MECHANICAL MINING IN SOME BITUMINOUS-COAL MINES

PROGRESS REPORT 7. METHODS OF MINING WITH CONTINUOUS-MINING MACHINES

By J. J. Shields, M. O. Magnuson, W. A. Haley, and J. J. Dowd

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MECHANICAL MINING IN SOME BITUMINOUS-COAL MINES

Progress Report 7. Methods of Mining With Continuous-Mining Machines

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INTRODUCTION

This is the seventh of a series of publications that describe methods and practices used in mining bituminous coal mechanically.[3] This report deals with the operation referred to in coal mining as continuous mining, and the interest shown by mining companies in this method is the reason for this study. Only continuous mining as it applies to the room-and-pillar system of mining, or a modification thereof, is discussed in detail in this report. Although not always as continuous as the name implies, it is a system of mining in which a machine is used to cut and load coal in one continuous operation without drilling and blasting the coal. With the mining equipment in most general use today, the usual cycle of operation in mining of coal is: (1) Timber, (2) cut, (3) drill, (4) blast, and (5) load. As the phases of this type cycle cannot be performed simultaneously in the same working place, it is necessary to operate from 3 to 7 working places so that at least 1 place is available for coal loading at all times. Even if the schedule of the phases in a cycle is maintained, coal production ceases during the time required to move the loading equipment from one loading place to the next.

In 1920 a continuous-type mining machine[4] was installed in an Illinois coal mine to drive entries. Several other companies used these entry drivers for short periods in the following few years. In 1927, a southern Illinois coal company installed 2 of these machines which, in the next 25 years, were reported to have driven over 200 miles of entries. The machines did not attain widespread usage.

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[3] Toenges, Albert L., and Anderson, Robert L., Multiple-Shift Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 1: Bureau of Mines Inf. Circ. 7014, 1938, 56 pp.
Toenges, Albert L., and Jones, Frank A., Multiple-Shift Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 2: Bureau of Mines Inf. Circ. 7067, 1939, 58 pp.
Toenges, Albert L., and Maize, Earl R., Multiple-Shift Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 3: Bureau of Mines Inf. Circ. 7178, 1941, 43 pp.
Toenges, Albert L., Maize, Earl R., and Jones, Frank A., Multiple-Shift Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 4: Extraction of Pillars With Mechanized Equipment: Bureau of Mines Inf. Circ. 7223, 1942, 59 pp.
Turnbull, Louis A., and Toenges, Albert L., Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 5: Extraction of Pillars With Mechanized Equipment: Bureau of Mines Inf. Circ. 7527, 1949, 59 pp.
Haley, Wilbur A., Shields, Joseph J., Toenges, Albert L., and Turnbull, Louis A., Mechanical Mining in Some Bituminous-Coal Mines. Progress Report 6: Extraction of Pillars With Mechanized Equipment: Bureau of Mines Inf. Circ. 7631 1952, 64 pp.

[4] Coal Age, Mining Methods and Mechanization: October 1936, p. 402.

In a paper[5] given before the American Mining Congress in 1948, it was reported that a coal-mine operator in 1926 foresaw a demand for smaller sizes of coal. For 5 years, he made unsuccessful efforts to persuade equipment manufacturers to construct a machine that could cut and load coal from a solid face in a single operation without blasting. Finally, the aid of a manufacturer of sugar beet machinery was enlisted, and in 1946 the forerunner of one of the present-day continuous-mining machines was placed in operation. Rapid strides have been made since that time, and many other types of continuous-mining machines have been made or are in the experimental stage.

With the introduction of continuous-mining machines, it was realized that systems of mining would have to be developed whereby these machines could be operated continuously to produce a steady flow of coal from the working face. The following factors, which would increase productivity per man and decrease costs, were visualized:

1. Drilling and blasting of coal would be eliminated from the mining cycle.

2. Hazards normally associated with drilling and blasting, such as ignition of dust and gases, handling of explosives, air contamination, and dangers from flying objects, would be eliminated.

3. Improved roof conditions could be expected because blasting would be eliminated.

4. Accidents at the face would be reduced, because the crew of the continuous-mining machine is further removed from the face than workmen in conventional mining.

5. Fewer working faces would have to be maintained and serviced to produce a given tonnage, thus permitting closer supervision.

6. To produce a given tonnage, fewer men would be needed because of the expected increased output per man shift.

7. The rapid advance of mining would shorten the time necessary to keep rooms open and thus reduce roof falls.

8. The better roof conditions expected could contribute to better overall recovery by permitting the mining of wider rooms in some mines and partial or complete pillar extraction in others.

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The Bituminous Coal Mining Branch expresses thanks to the officials of the coal-mining companies for their cooperation and for courtesies extended to the Bureau engineers assigned to the study. Suggestions and comments of mine officials who reviewed the individual mine reports and who granted permission to the Bureau to publish the information contained in the reports are appreciated. Assistance given by the manufacturers of the continuous-mining equipment is appreciated also.

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[5] Blose, Stanley, The Continuous Miner: Am. Min. Cong. Yearbook, 1948, p. 73.

SUMMARY AND CONCLUSIONS

The conclusions and curves given in this report are the result of detailed studies of 20 mines in 6 States in coal-producing fields of the United States. Conclusions regarding: (1) Mining systems and recovery; (2) roof control; (3) face haulage; (4) productive time; (5) comparison of performance of continuous-mining and mobile-loading units; and (6) production curves follow:

1. Mining systems and recovery.[6] - Mining systems follow the conventional room-and-pillar or the block development plan or modifications thereof. Pillars were extracted wholly or in part by continuous-mining machines in 12 of the 20 mines studied. The percent of production and recovery by continuous-mining methods at these mines follow: 3 mines, 100 percent of production with recovery ranging from 85 to 90 percent; 4 mines, 65 to 80 percent of production with recovery ranging from 60 to 92 percent; 4 mines, 21 to 37 percent of production with recovery ranging from 85 to 93 percent; and 1 mine, 4.8 percent of production with 96 percent recovery. Recovery figures include mining by continuous-mining, mobile-loading, and hand-loading units in 9 of the 12 mines.

2. Roof control. - As in conventional, hand-loading, and mechanical mining methods, effective roof control is most important. A method of roof support must be provided that will insure safety to workmen and equipment and allow the continuous-mining machine to operate without undue delay. Roof bolting was used to advantage in some mines; in other mines, wood and steel crossbars were set on steel jacks or wood posts; and other mine roofs required only wood or steel posts with wood cap pieces. Roof conditions generally were better in the continuous-mining sections of a mine than in the mobile-loading sections. At the cleaning plants at two of the mines studied, the reject was 8 and 13 percent of the raw coal from the continuous-mining sections; and 30 and 20.4 percent, respectively, from the mobile-loading sections. Both mines, widely separated, left top coal in the continuous-mining section to protect the overlying draw slate and used wood crossbars on wood posts as roof supports; whereas no top coal was left in the mobile-loading sections. Probably because of the top coal and the absence of blasting in the continuous-mining sections, fewer falls contaminated the coal, and a cleaner product to the preparation plant was assured. Roof conditions in sections where pillars were extracted with continuous-mining machines generally were better than in similar areas in the same mines where pillars were extracted by mobile-loading units. Continuous mining lends itself to the concentrated and rapid extraction of pillars (by splitting, open-end, or pocket-and-fender method). As only one working place is active at one time for each unit operating on a pillar line, better roof control can be maintained to provide safer working conditions than with conventional mining.

3. Face haulage. - Methods of coal loading and transporting coal away from the continuous-mining machine varied in the 20 mines studied and are tabulated in table 1. Shuttle cars were used to transport the coal away from the continuous-mining machine in all of the mines studied. However, two of the mines were operating continuous-mining machines, which loaded directly onto portable or chain conveyors. The maximum tramming distance from the continuous-mining machine to the unloading station was kept to 300 feet or less to reduce delay caused by waiting on the shuttle-car return. In some mines, the coal is deposited on the floor by the mining machine and then loaded into the shuttle cars by a loading machine. This practice provides temporary storage, better clean-up, and allows the mining machine to operate with a

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[6] Recovery figures furnished by operator and are not the result of Bureau engineers' study or verification.

minimum of stoppage. Loading into a surge car was the most common practice observed at the mines studied. However, no one method, based on an analysis of productive time, tons per unit, and tons per man on the unit, showed any significant advantage over the others.

TABLE 1. - Method of face transportation

Mine No.	Sequence of transfer from continuous-mining machine to section haulage	Section haulage
1[1]	Loading machine - surge car - shuttle car	30-inch belt
2	Shuttle car	36-inch belt
3	Surge car - shuttle car	10-ton mine car
4	do	7-ton mine car
5	Shuttle car - shaking conveyor)	30-inch belt
	Portable conveyor)	Do.
6[1]	Loading machine - shuttle car	5-1/2-ton mine car
7	Surge car - shuttle car	30-inch belt
8[1]	Loading machine - shuttle car	Do.
9	Shuttle car	Do.
10	Surge car - shuttle car	Do.
11	do	Do.
12	do	Do.
13[1]	Loading machine - shuttle car	4-1/2-ton mine car
14	Shuttle car	6-ton mine car
15	Surge car - shuttle car	6-1/2-ton mine car
16	Chain conveyor)	26-inch belt
	Shuttle car)	Do.
17	Surge car - shuttle car	30-inch belt
18[1]	Loading machine - shuttle car	5-ton mine car
19[1]	do	5.2-ton mine car
20	Surge car - shuttle car	1.9-ton mine car

[1] Coal deposited on mine floor by continuous-mining machine.

4. Productive time. - Productive time (face time less all delays) ranged from 2.58 to 5.67 hours in the 20 mines studied. (See table 2.) Major operating delays resulted from mechanical breakdowns on equipment, work stoppage to permit timbering, haulage interruptions, and moving or maneuvering equipment. In five mines lunch time loss was eliminated by staggering lunch periods of the crew members.

5. Comparison of performance of continuous-mining and mobile-loading units. - Performance of continuous-mining and mobile-loading units at the same mines is compared in table 3. Mines are shown in order by thickness of bed mined. No distinction of performance for mines extracting pillars and mines not extracting pillars was made in this study. Productivity of raw coal per man shift by continuous-mining units was greater than that by mobile-loading units for the same thickness of coal at the same mine. These differences ranged from 2.7 to 45.3 tons of raw coal per man shift.

TABLE 2. - Distribution of 8-hour shift

Mine No.	Time - hours					
	Travel	Lunch	Face	Mechanical delays	Other delays	Productive
1	1.00	(1)	7.00	0.65	1.40	4.95
2	1.00	0.50	6.50	1.00	2.50	3.00
3	1.25	.50	6.25	.70	1.25	4.30
4	.67	.50	6.83	1.50	.50	4.83
5	.50	(1)	7.50	.28	2.52	4.70
6	1.33	.50	6.17	1.00	.17	5.00
7	1.67	.50	5.83	.83	1.80	3.20
8	.50	.50	7.00	.67	1.08	5.25
9	2.25	(1)	5.75	.67	2.50	2.58
10	2.00	(1)	6.00	1.00	.50	4.50
11	1.25	(1)	6.75	.50	1.00	5.25
12	1.00	.50	6.50	.83	.17	5.50
13	1.50	.50	6.00	.40	1.93	3.67
14	1.25	.50	6.25	1.00	1.50	3.75
15	1.10	.50	6.40	.32	1.00	5.08
16	.80	.50	6.70	1.10	.50	5.10
17	.33	.50	7.17	1.20	.30	5.67
18	1.00	.50	6.50	1.50	2.00	3.00
19	1.00	.50	6.50	1.00	1.33	4.17
20	1.50	.50	6.00	.67	.33	5.00

1/ No time loss - crew lunch period staggered.

TABLE 3. - Comparison of performance of continuous mining and mobile loading

Mine No.	Bed thickness mined, inches	Continuous mining		Mobile loading	
		Raw coal - tons		Raw coal - tons	
		Per unit per shift	Per man per shift on unit	Per unit per shift	Per man per shift on unit
9	41	179.9	27.7	90.6	9.7
16	42	101.0	13.5	(1)	(1)
7	42	104.8	17.5	123.8	14.8
11	42	121.0	22.8	89.1	11.1
8	42	139.0	23.6	183.0	15.3
10	43	133.3	22.2	100.0	9.1
5	48	150.0	23.1	(1)	(1)
16	53	105.2	19.1	(1)	(1)
17	54	250.0	38.5	200.0	16.7
1	54	369.2	46.1	190.2	19.0
12	55	180.0	27.7	155.0	15.5
6	57	199.7	30.7	130.0	17.0
20	58	141.7	19.8	141.7	11.8
18	72	565.0	70.6	304.0	25.3
19	73	209.0	29.8	306.0	21.6
13	74	188.5	26.9	(1)	(1)
15	76	210.0	32.3	277.7	17.4
4	84	278.0	61.8	385.0	39.8
2	84	313.6	48.3	(1)	(1)
14	90	206.0	29.4	154.9	14.5
3	102	293.5	48.9	373.0	25.9

1/ No production from mobile-loading units.

6. Production curves. - Production data for the 2 types of mining at the 20 mines studied are shown graphically for comparative purposes by plotting tons of raw coal per man per shift in the unit crew against mining thicknesses. (See fig. 1.) Group-weighted average points were calculated and plotted for groups of mines having nearly the same mining thickness. The curves shown were based on these points. The curve for continuous mining tends to flatten off at 102 inches. However, this trend is not conclusive because: (1) Only one mine in this bed-thickness category was included in the study, and (2) continuous-mining machines mining greater bed thicknesses were not available for this study. Probably the same gradual upward trend of the production curve would be maintained in mining bed thicknesses greater than 102 inches if continuous-mining machines were developed to mine greater bed thicknesses. In opening a new mine or in converting an old mining system to continuous mining, it is possible froma the curves shown to approximate the tons of raw coal per man shift in unit crews that could be produced for different bed thicknesses.

For the mines described in this report, the studies show that continuous mining is the most productive method of underground mining whether pillars are or are not extracted. Cleaning and sizing of the product does not seem to pose any difficult problems for most preparation plants. In fact, in two of the mines studied using continuous-mining and mobile-loading equipment, the reject from continuous mining was 4 and 8 percent and from mobile loading, 10 and 20 percent.

It can be expected that in the next decade, continuous mining will largely supplant the conventional systems of mining now in use. New types of continuous-mining machines, in addition to improved models of the present-type machines, development of continuous systems of coal transportation, roof-control methods that will not interfere with continuous operation, and new mining systems, will be introduced and result in safer and better working conditions and greater productivity per man employed.

METHOD OF PROCEDURE

The purpose of the study was to determine and report on how continuous-mining equipment is used in mining bituminous coal, the plans of mining devised for use of such equipment, and how the results attained compare with conventional-mining methods where both methods are in use at the same time.

After permission was granted by a coal company, Bureau engineers entered the mine, observed the plan of mining, and studied all phases of the operation for several days. Sketches were made of the mining plan to show the method of mining with the continuous-mining machine. The thickness of the coal, thickness and location of partings, thickness of that part of the bed mined, and thickness and stratification of the overburden were determined.

The duties of all full-time crew members were observed as well as the duties of workmen who spent only part of the shift with the unit. Time studies were not made during the underground observations, as the time allotted at each mine was insufficient to obtain representative data. Pertinent data relative to production, classification of employees, and all delays covering operating periods of not less than a full month, were taken from company records.

At the conclusion of the study at each mine, a report was prepared and submitted to the mine operator for comments and approval for publication.

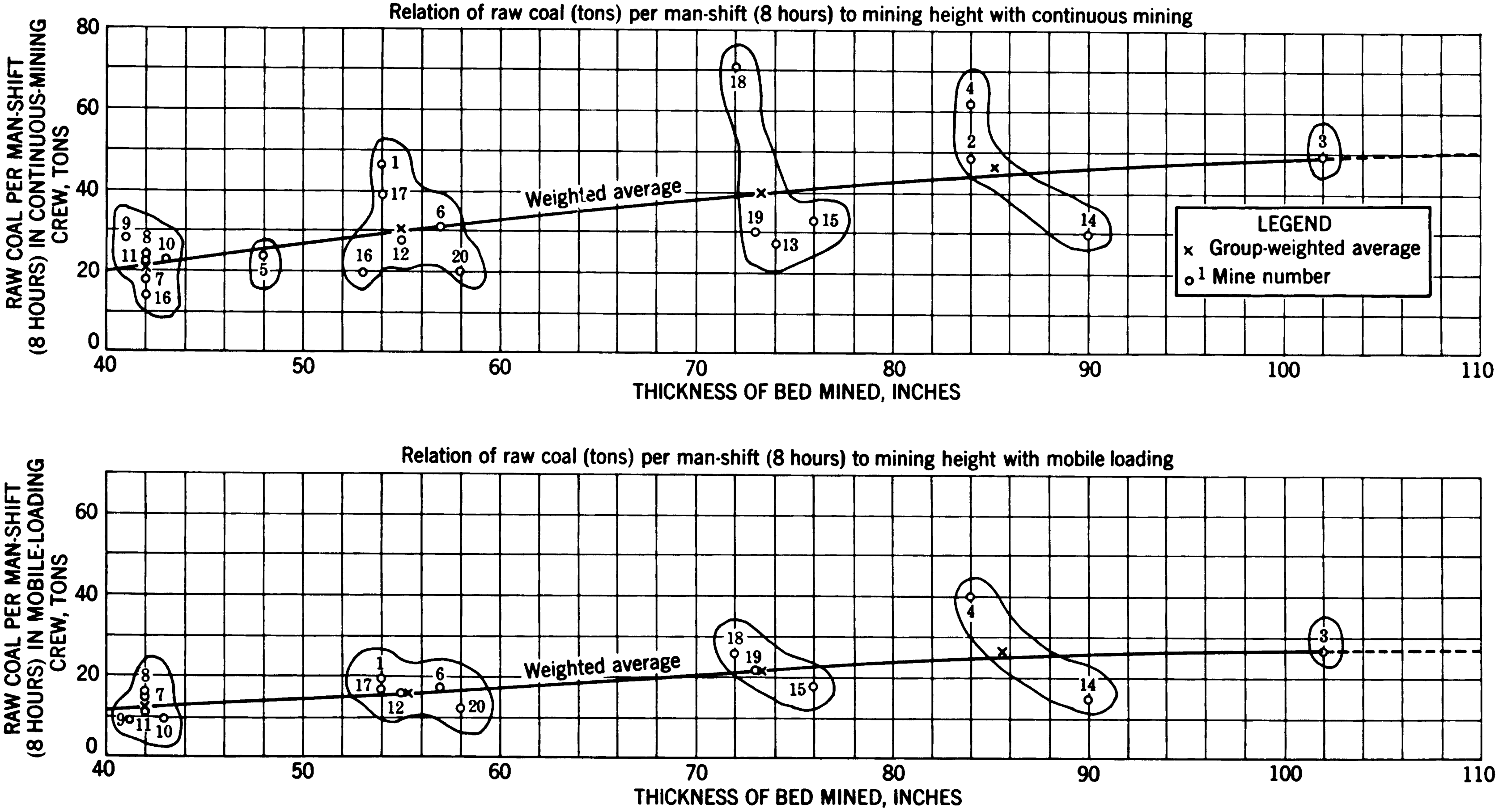

Figure 1. - Comparison of performance of continuous mining and mobile loading at 20 bituminous-coal mines.

TYPES OF CONTINUOUS-MINING MACHINES STUDIED

Three general types of continuous-mining machines are included in the study and will be referred to as types A, B, and C in this report.

Type A

Type A machine applies a ripping action to the coal face with cutting bits set in chains or sprockets moving at high speed. No distinction is made as to whether the cutting head moves upward or downward or transversely at an angle on the coal face during mining.

Type B

Type B continuous-mining machine applies a slow-speed boring action to the coal face through a series of rotating arms in which the cutting bits are held.

Type C

Type C continuous-mining machine applies a slow-speed boring action also, but this action is applied by two rotating arms equipped with cutting bits. This type uses cutting chains for trimming unmined coal in the top and bottom of the working face.

MINES STUDIED

Twenty reports on continuous mining were made for mines in Alabama, Illinois, Kentucky, Ohio, Pennsylvania, and West Virginia.

Each mine is referred to by a number and pertinent data are given. Included are illustrations showing: (1) Section of coal bed and overburden; (2) map showing the general method of mining; and (3) method of entry development with continuous-mining equipment and/or room or pillar mining with continuous-mining equipment.

A detailed description is given of the continuous-mining operation, including the components of a continuous-mining unit. A unit is a group of men, one continuous-mining machine, and the auxiliary equipment operated by that group to mine, load, and transport the coal to the mainline haulage. Personnel of the unit crew are listed according to the job classification at the mine. If a member of the unit crew performs work daily for two or more units, that crew member is listed fractionally (1/2, 1/3, or 1/6) for each of the units served.

The total number of employees actually working on an average workday are classified according to those in continuous-mining units or conventional-mining units, supervisory and inspection personnel, other underground employees, and surface employees. There are more names on each mine payroll than are shown as "Total employees" in these tabulations because of absenteeism for various reasons. In the tabulation "Classification of Employees," the supervisory and inspection employees are in addition to the foremen listed as crew members. "Other underground employees" are mainline transportation men, general underground maintenance men, and other underground workers who are not crew members of either continuous-mining or conventional-mining units.

A summary of performance of the continuous-mining units at each mine is given. A summary of performance of conventional units and a comparison with continuous-mining units also is given for each mine having both type of units. To get the total number of employees chargeable to each method of mining (in addition to the men on the unit crews), supervisory, other underground, and surface employees were prorated according to the tons of raw coal produced by each method of mining. This arbitrary method of distribution of other underground and surface employees may not reflect an accurate division in every case. Such factors as the extent of the mine workings, location in the mine of the continuous-mining units, amount of underground maintenance, type and size of surface plant at each mine, cost-accounting system used at each mine, and other factors could materially affect the accuracy of the prorated data. For these reasons, the production results per man shift of the unit crew is the basis for a more reliable comparison. All production data are based on tons of raw coal rather than clean coal because the raw coal actually is the total material handled by the units.

DESCRIPTION OF MINING OPERATIONS

Details of the study made at each mine follow:

Mine 1

Location		Alabama
Coal bed and thickness (fig. 2)	inches	America - 54
Thickness of overburden (fig. 2)	feet	216
Production per day, raw coal	tons	6,712
Total employees		521
Type A continuous-mining machines:		
Entry development		1
Room mining		5
Mobile-loading units		6
Shifts per day		2
System of mining (fig. 3)		Room-and-pillar, pillars not extracted
Estimated recovery of coal in place	percent	65
Mainline haulage		Locomotive

Mining Method

One type A continuous-mining machine, operated two unit shifts per day, is used to develop a set of four main entries. (See fig. 4.) The solid line represents the coal face at the end of a complete cycle of operations and the broken line, the advance of the coal face at the end of the next complete cycle of operation (cuts 1 to 6). Entries and crosscuts developed by the continuous-mining machine are roof bolted on 4-foot centers (three bolts to a row), using 3/4-inch diameter expansion-shell-type bolts, 30 and 40 inches long. Each bolt is set against a 6- by 6- by 3/8-inch steel plate. Track entry B is top brushed to 6 feet above the rail and rebolted. The continuous-mining machine discharges the coal onto the floor. A mobile-loading machine loads the coal into a 3-1/2-ton-capacity shuttle car, which is used as a surge car. The coal is transported in the shuttle car to the unloading station and dumped into an elevating conveyor, which conveys the coal to a standard chain conveyor from where it is delivered to 5.6-ton-capacity, steel, bottom-dump mine cars.

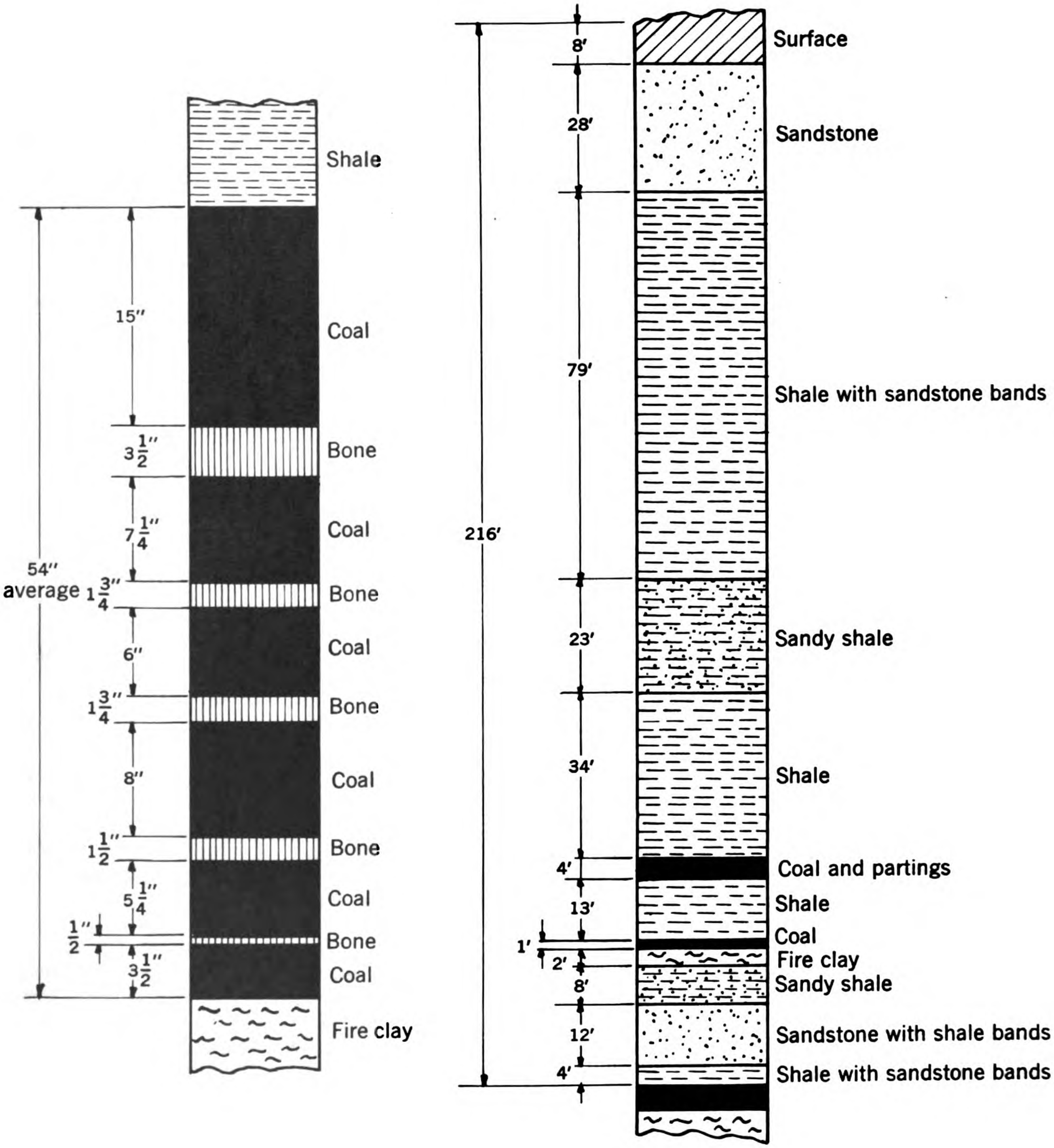

Figure 2. - Section of coal bed and overburden at mine 1.

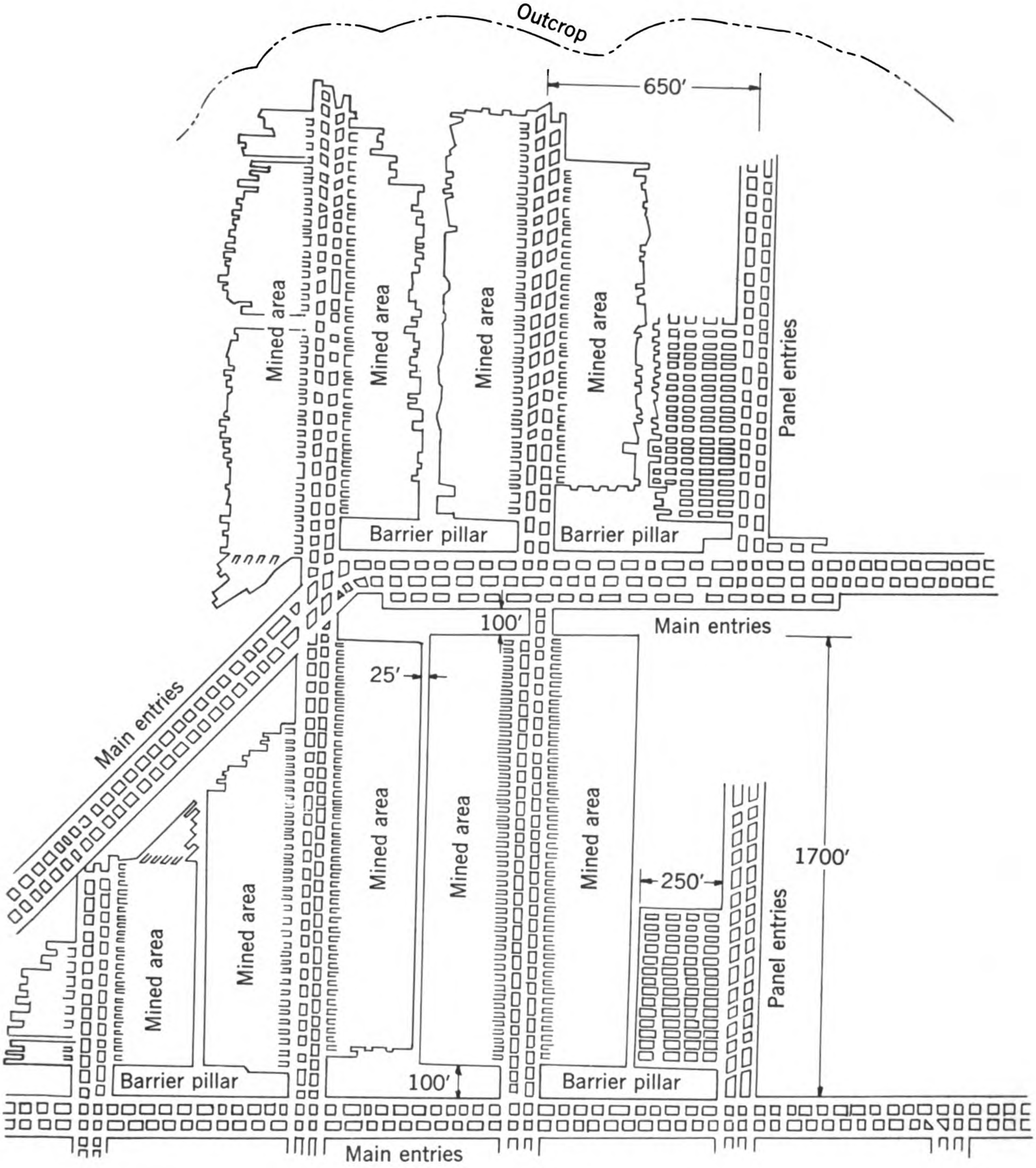

Figure 3. - Mining method at mine 1.

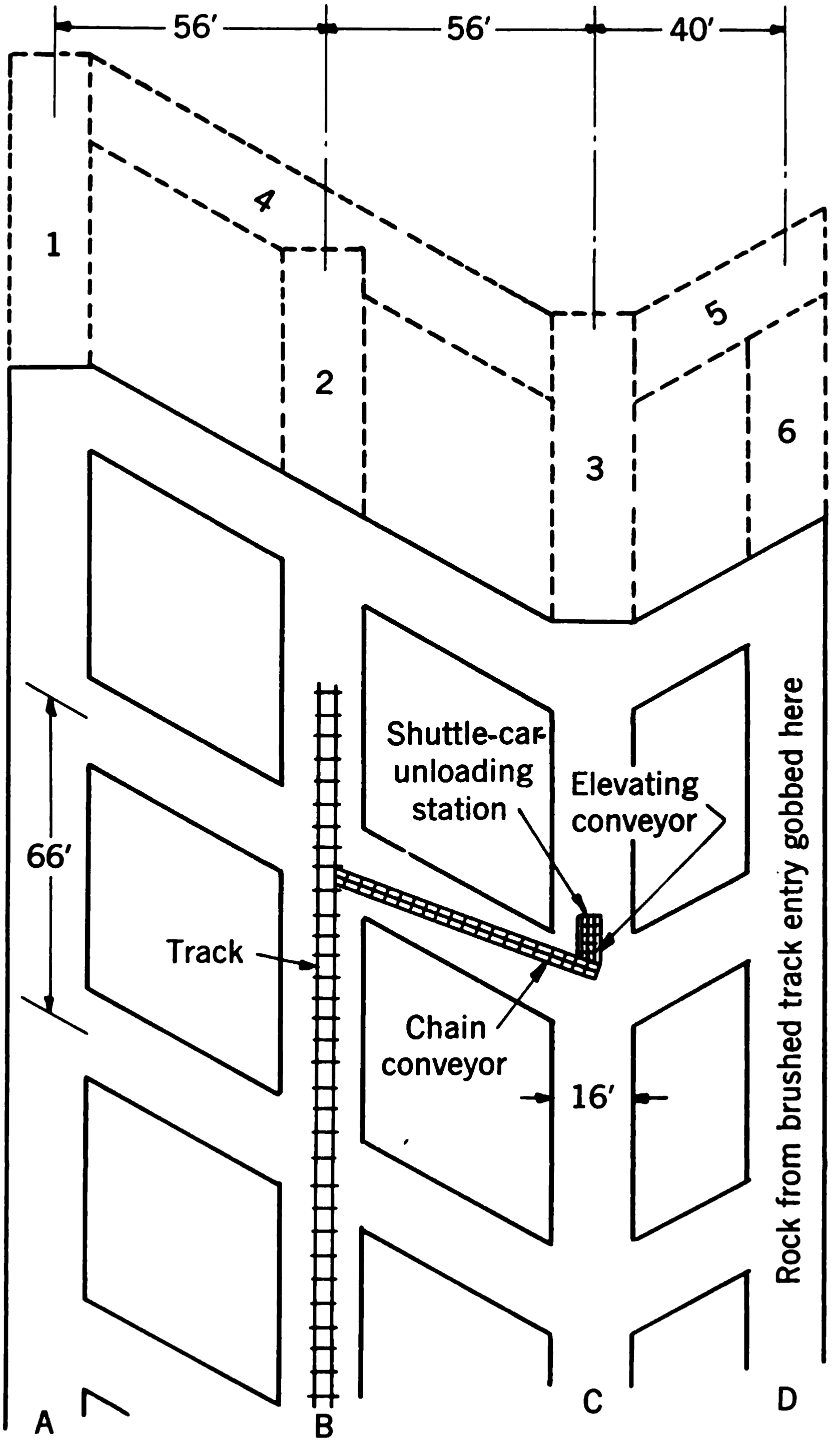
56′
56′
40′
1
4
2
3
5
6
Shuttle-car unloading station
Elevating conveyor
66′
Track
Chain conveyor
16′
Rock from brushed track entry gobbed here
A
B
C
D

Figure 4. - Main-entry development at mine 1.

Five type A continuous-mining machines, operated 10 unit shifts per day, are used to develop rooms from both sides of a panel. Usually, the rooms on one side of the panel entries are worked on advance and those on the other side, on retreat. The middle entry is equipped with a 30-inch belt, which transports the coal to the main haulage entry and discharges into steel mine cars. The plan for developing rooms is shown in figure 5. Rooms A and B are driven by making cuts 1 to 5, inclusive. Succeeding rooms are driven by repeating the sequence of cuts 6 to 17. Wood crossbars, 14 feet long by 8 inches wide by 3 inches thick, set on steel screw jacks are used to support the roof. The crossbars are set on 4-foot centers as the continuous-mining machine advances and are recovered (along with the steel screw jacks) when the room is completed. The continuous-mining machine discharges the coal to the floor from where it is loaded by a mobile-loading machine to a 3-1/2-ton-capacity shuttle car, used as a surge car. These operations permit the continuous-mining machine to be operated with a minimum of delay for alignment with or waiting on shuttle cars. The coal is transported from the surge car by a 3-1/2-ton shuttle car to the 30-inch panel belt and discharged. The average advance of the continuous-mining machine in entries and rooms is 135 feet per shift.

In room development, a continuous-mining unit comprises 8 men, 1 continuous-mining machine, 1 mobile-loading machine, 2 shuttle cars, and one 26- or 30-inch panel belt. In entry development, a continuous-mining unit comprises 8 men, 1 continuous-mining machine, 1 mobile-loading machine, 2 shuttle cars, 1 elevating conveyor, and 1 standard chain conveyor.

A continuous-mining crew consists of 8 men as follows:

Section foreman	1
Continuous-mining-machine operator	1
Continuous-mining-machine helper	1
Loading-machine operator	1
Shuttle-car operators	2
Car trimmer	1
Electrician-mechanic	1
Total	8

Travel time at this mine is 1 hour; no time lost for lunch (crew lunch period staggered); leaving 7 hours face time per shift. The average delay caused by mechanical failure is 39 minutes, 9.3 percent of face time. Other delays, as maneuvering the continuous-mining machine, timbering, power failure, bit change, greasing, and waiting for empty cars, amount to 1 hour 24 minutes, 20 percent of face time. Actual productive time is 4 hours 57 minutes, 70.7 percent of face time. All maintenance, moving, and other work necessary to keep the continuous-mining machine operating is done on the operating shift. On the third shift, which is nonoperating, moveups are made by the regular moveup crews, and heavy maintenance work is done by an electrician-mechanic and helper.

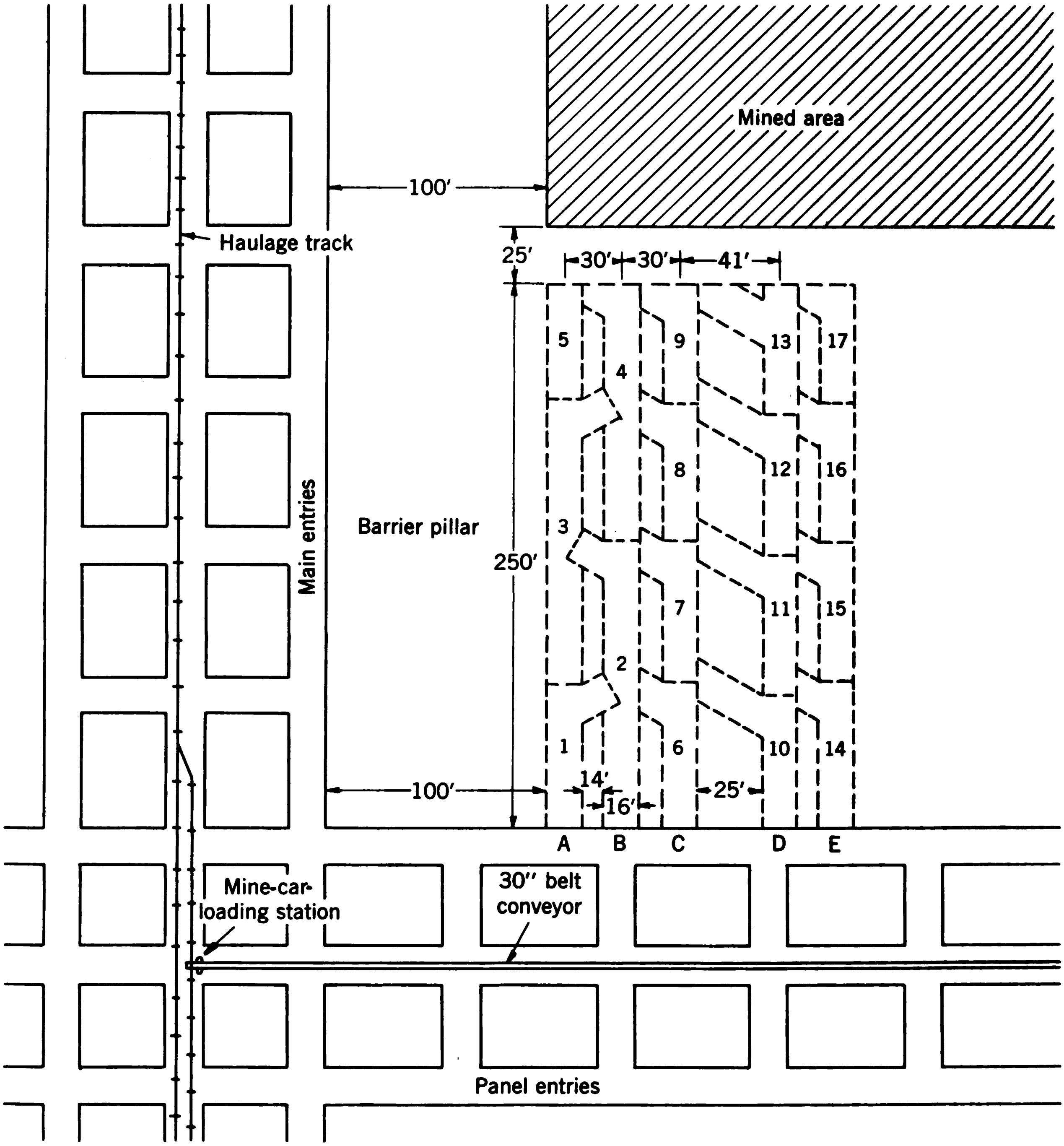

Figure 5. - Room mining at mine 1.

Classification of Employees

Classification	Shift[1] 1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	6	6	-	12
Continuous-mining-machine operators	6	6	-	12
Continuous-mining-machine helpers	6	6	-	12
Loading-machine operators	6	6	-	12
Shuttle-car operators	12	12	-	24
Car trimmers	6	6	-	12
Electrician-mechanics	6	6	-	12
Total employees, continuous-mining units	48	48	-	96
Total employees, mobile-loading units	60	60	-	120
Supervisory and inspection	13	11	6	30
Other underground employees	90	55	40	185
Total underground employees	211	174	46	431
Total surface employees	68	17	5	90
Total surface and underground employees	279	191	51	521

---

[1] 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 3:00 p.m. to 11:00 p.m.
3d shift -11:00 p.m. to 7:00 a.m.

Summary

	Continuous mining	Conventional mining
Percent of mine production	66	34
Hours per shift	8	8
Unit shifts per day	12	12
Average yield of clean coal ... percent	73	73
Average advance of continuous-mining machine per shift ... feet	135	-
Employees:		
In unit crews	96	120
Supervisory and other underground	142	73
Surface	59	31
Total charged to	297	224
Average daily production, raw coal ... tons	4,430	2,282
Average production, raw coal per unit per shift.. tons	369.2	190.2
Average production, raw coal per man per shift on unit ... tons	46.1	19.0
Average production, raw coal per underground man shift ... tons	18.6	11.8
Average production, raw coal per payroll man shift ... tons	14.9	10.2

Mine 2

Location		Illinois
Coal bed and thickness (fig. 6)	inches	No. 6 - 108 (84 inches mined)
Thickness of overburden (fig. 6)	feet	800
Production per day, raw coal	tons	7,527
Total employees		388
Type A continuous-mining machines:		
Entry pillar extraction		3
Type C continuous-mining machines:		
Entry development		5
Room mining		4
Shifts per day		2
System of mining (fig. 7)		Room-and-pillar, pillars extracted
Estimated recovery (mined portion	percent	90
Mainline haulage		48- to 60- to 42-inch belt

Mining Method

Three type A continuous-mining machines, operated six unit shifts per day, are used to extract panel-entry pillars, as shown in figure 8 at A. The east panel pillar is split through the middle, and 3 cuts, each 13 feet wide, are made. (See cuts 1 to 4.) The west panel pillar then is split (cut 5), and cuts 6, 7, and 8, each 13 feet wide, are made. The continuous-mining machine then is retracted and cut 9 is made. Cuts 10, 11, and 12 then are made to complete the extraction of the south half of the panel pillars. Cuts 13 to 22, inclusive, are made to extract the north half of the pillars. This cycle of operations is repeated in extracting all panel-entry pillars. The average advance of the type A continuous-mining machine is 100 feet per shift. The small stumps of coal that are left crush without causing any overriding on the pillars.

Nine type C continuous-mining machines, operated 18 unit shifts per day, are used to develop panel entries and rooms and to extract room pillars. At the time of this study, 5 type C continuous-mining machines were developing entries, and 4 type C continuous-mining machines were developing rooms and extracting pillars.

The plan for developing panel entries is shown in figure 9. The solid lines in entries 1, 2, and 3 represent the advance of the face at the end of a complete cycle of operations. The broken lines represent the advance of the face at the end of the succeeding cycle of operations (cuts 1 to 6). The average advance of the type C continuous-mining machines is 125 feet per shift. Entries are roof bolted on 3-foot centers in alternate rows of 1 bolt in the center of the entry in the first row, and the next row with 2 bolts set 2-1/2 feet either side of the center. Roof bolts are 3/4-inch diameter, 5 feet long (expansion-shell type), set against 6- by 6- by 3/8-inch steel plates. The oval shape of the entry mined by the type C continuous-mining machine tends to leave stronger roof requiring a minimum of roof support.

The plan for room mining and pillar extraction with the type C continuous-mining machine is shown at B in figure 8. Pairs of rooms are developed with a solid pillar left between each pair. Pillars are split through the center and then extracted by succeeding cuts. (See cuts 1 to 6.) Breaker posts, when required, are set on 3-foot centers to induce roof fracture and caving.

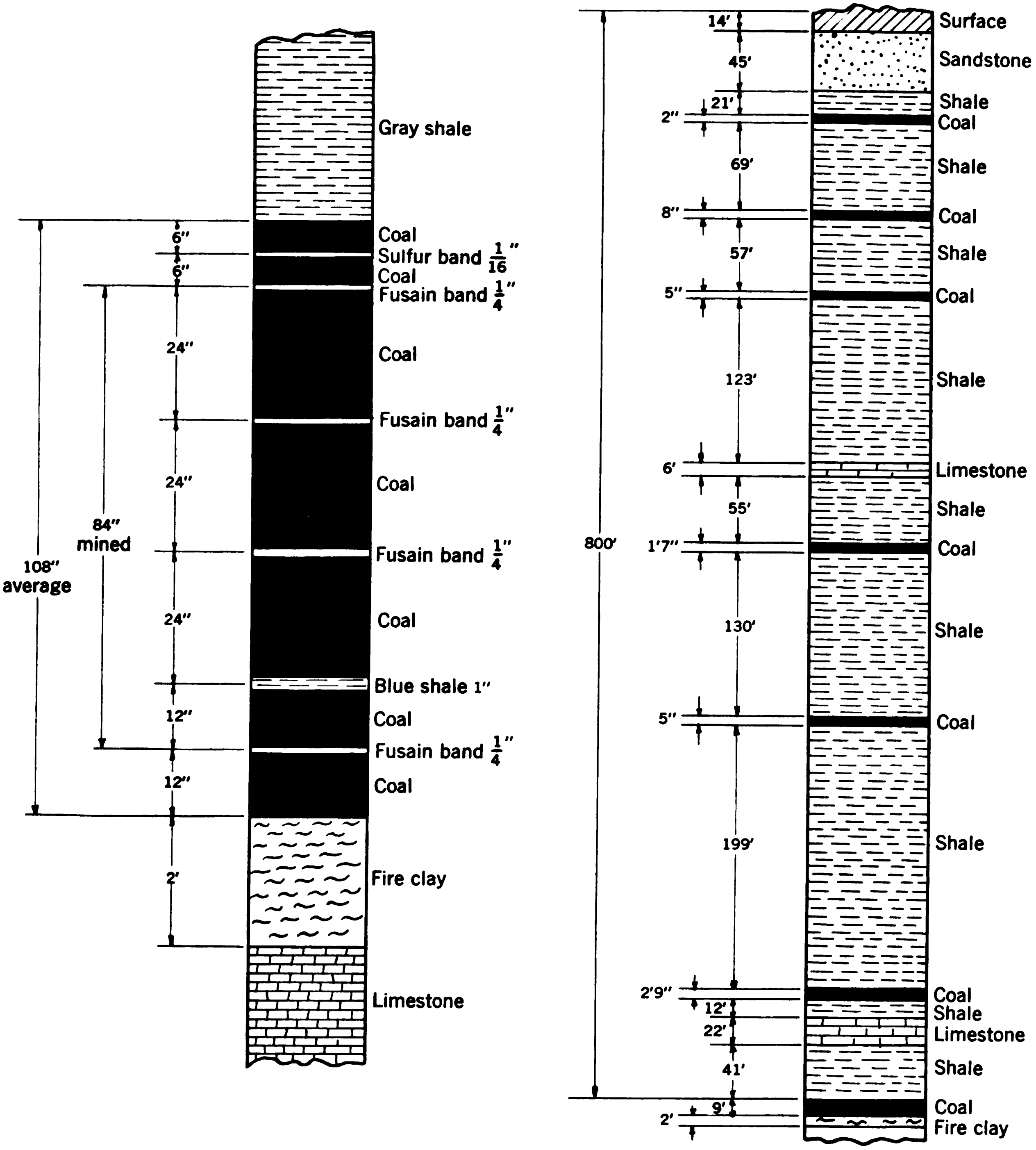

Figure 6. - Section of coal bed and overburden at mine 2.

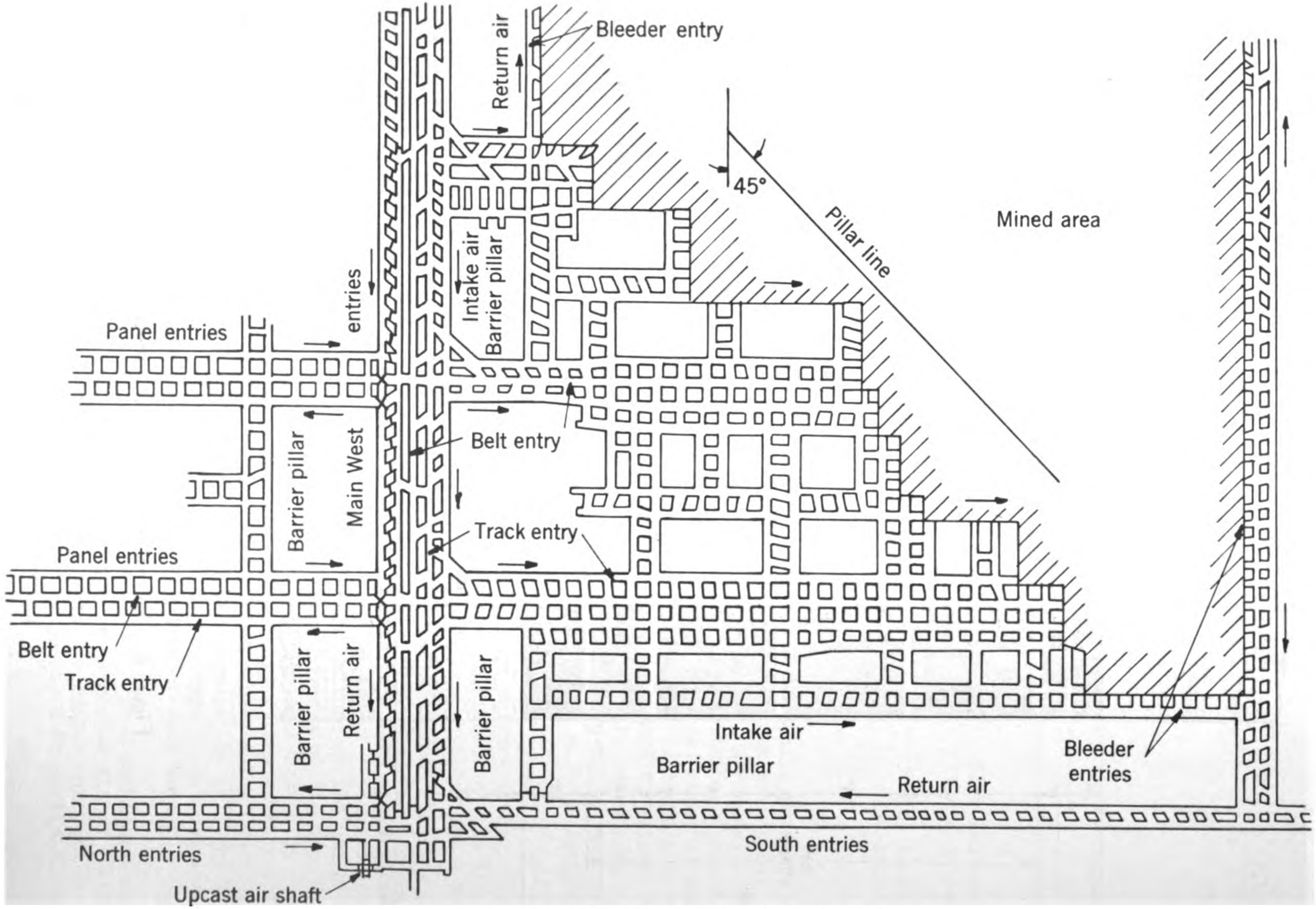

Figure 7. - Mining method at mine 2.

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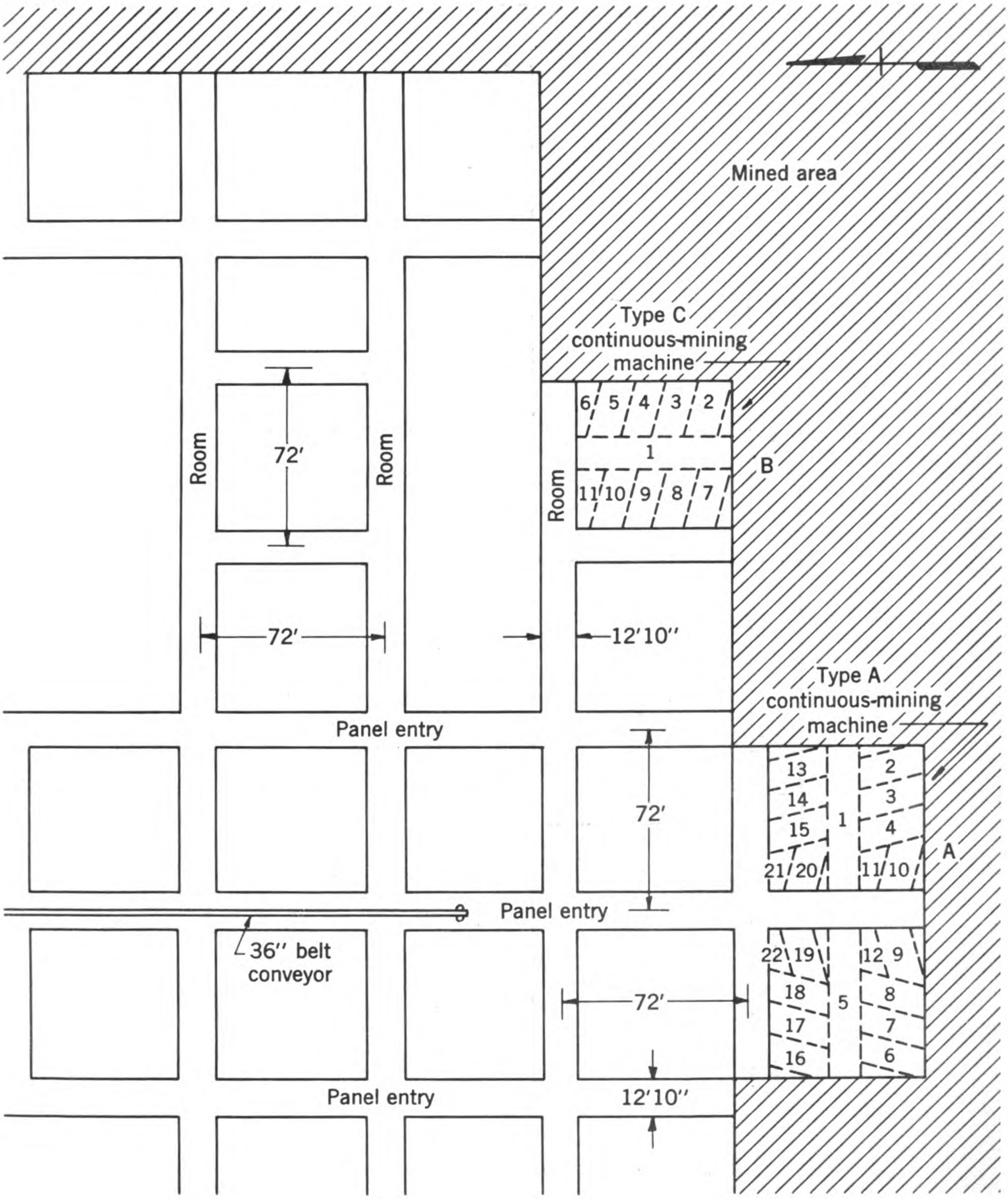

Figure 8. - Pillar extraction at mine 2.

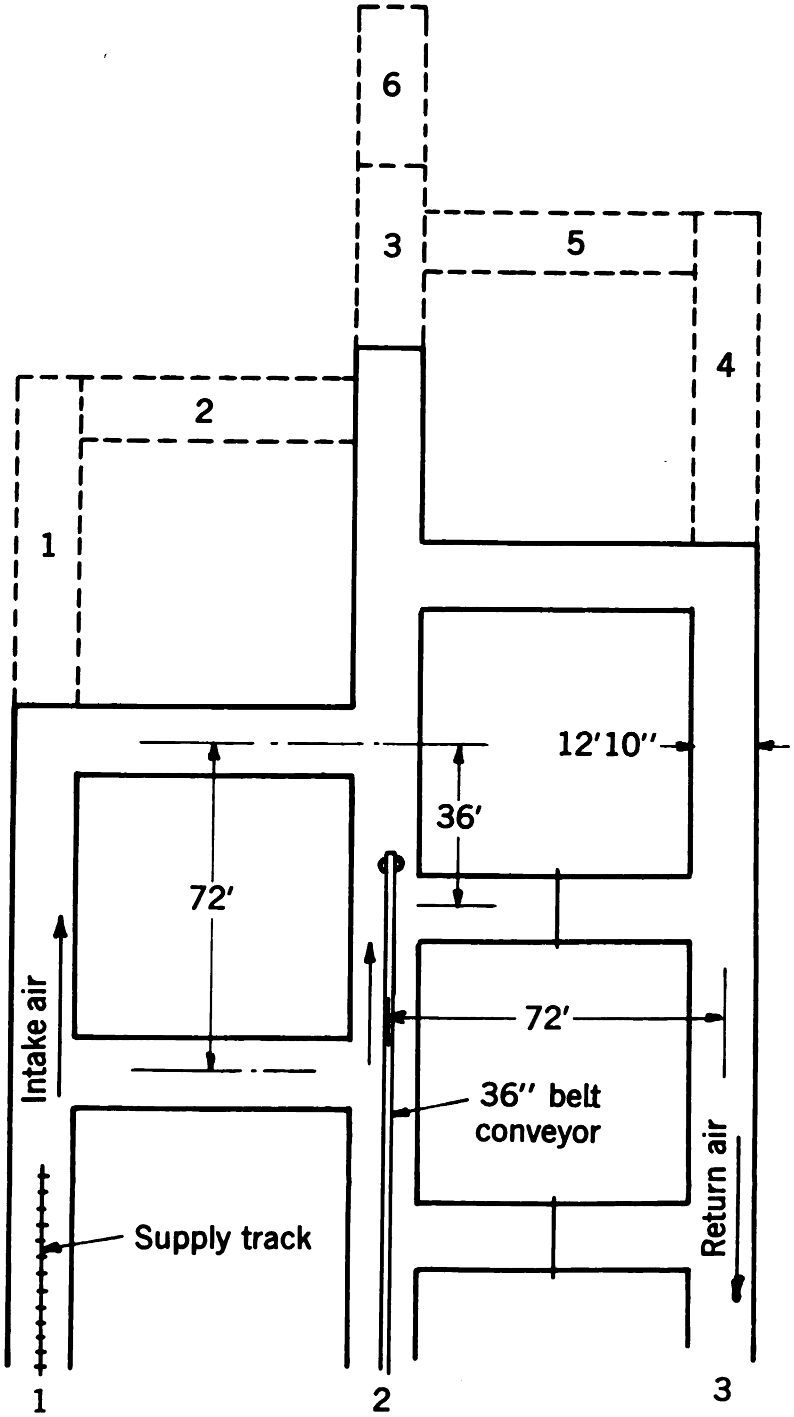

Figure 9. - Panel-entry development at mine 2.

A continuous-mining unit of either type comprises 6-1/2 men, 1 continuous-mining machine, 2 shuttle cars, and one 36-inch belt. Coal is loaded from the continuous-mining machine into 7-ton shuttle cars, each equipped with an elevating conveyor, and transported to the end of the belt, where it is discharged onto the belt. Panel belts are extended in entry development or retracted in pillar extraction in 144-foot lengths to keep the shuttle-car round trip less than 500 feet.

A continuous-mining crew consists of 6-1/2 men as follows:

Section foreman	1/3
Continuous-mining-machine operators	2
Shuttle-car operators	2
Timberman	1
Repairman (mechanic)	1/2
Beltman	2/3
Total	6-1/2

Travel time at this mine is 1 hour; lunch time, 30 minutes; leaving 6 hours 30 minutes face time per shift. The average delay caused by mechanical failure and bit changes is 1 hour, 15.4 percent of face time. Other delays, retracting the continuous-mining machine, shuttle-car delays, and power failure, amount to 2 hours 30 minutes, 38.5 percent of face time. Actual productive time is 3 hours, 46.1 percent of face time. All maintenance, moving, and other work necessary to keep the continuous-mining machines operating are done on the third shift by a repair crew.

Classification of Employees

	Shift[1]			
Classification	1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	1	1	-	2
Continuous-mining-machine operators	6	6	-	12
Shuttle-car operators	6	6	-	12
Timbermen	3	3	-	6
Repairmen (mechanics)	1	2	-	3
Beltmen	2	2	-	4
Total employees, type A continuous-mining units	19	20	-	39
Type C continuous-mining units:				
Section foremen	3	3	-	6
Continuous-mining-machine operators	18	18	-	36
Shuttle-car operators	18	18	-	36
Timbermen	9	9	-	18
Repairmen (mechanics)	5	4	-	9
Beltmen	6	6	-	12
Total employees, type C continuous-mining units	59	58	-	117
Total employees, continuous-mining units	78	78	-	156
Supervisory and inspection	10	7	8	25
Other underground employees	26	11	52	89
Total underground employees	114	96	60	270
Total surface employees	80	31	7	118
Total surface and underground employees	194	127	67	388

---

[1] 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 3:00 p.m. to 11:00 p.m.
3d shift - 11:00 a.m. to 7:00 p.m.

Summary

	Continuous mining	
	Type A	Type C
Percent of mine production	25	75
Hours per shift	8	8
Unit shifts per day	6	18
Average yield of clean coal....percent	93	93
Average advance of continuous-mining machine per shift....feet	100	125
Employees:		
In unit crews	39	117
Supervisory and other underground	28	86
Surface	30	88
Total charged to	97	291
Average daily production, raw coal....tons	1,882	5,645
Average production, raw coal per unit per shift....tons	313.6	313.6
Average production, raw coal per man per shift on unit....tons	48.3	48.3
Average production, raw coal per underground man shift....tons	27.9	27.9
Average production, raw coal per payroll man shift....tons	19.4	19.4

Mine 3

Location	Illinois
Coal bed and thickness (fig. 10)....inches	No. 6 - 102
Thickness of overburden (fig. 10)....feet	274
Production per day, raw coal....tons	5,060
Total employees	382
Type A continuous-mining machine:	
Entry development	1
Mobile-loading units	6
Shifts per day	2
System of mining (fig. 11)	Room and pillar, pillars not extracted
Estimated recovery of coal in place....percent	45
Mainline haulage	Locomotive

Mining Method

One type A continuous-mining machine, operated two unit shifts per day, is used to develop a set of four main entries. (See fig. 12.) The solid line represents the coal face at the end of a complete cycle of operations and the broken line, the advance of the coal face at the end of the next complete cycle of operations (cuts 1 to 8). Every third crosscut between each pair of entries is connected by a crosscut through the pillar between the pairs of entries (cut 7, fig. 12). The average advance of the continuous-mining machine in entries and crosscuts is 65 feet per shift. Entries are roof bolted along the centerline with 2- by 8-inch by 4-foot long woodboards set on 4-foot centers and bolted to the roof with two 3/4-inch-diameter, wedge-type bolts, 5 feet long, set against 6- by 6- by 3/8-inch steel plates.

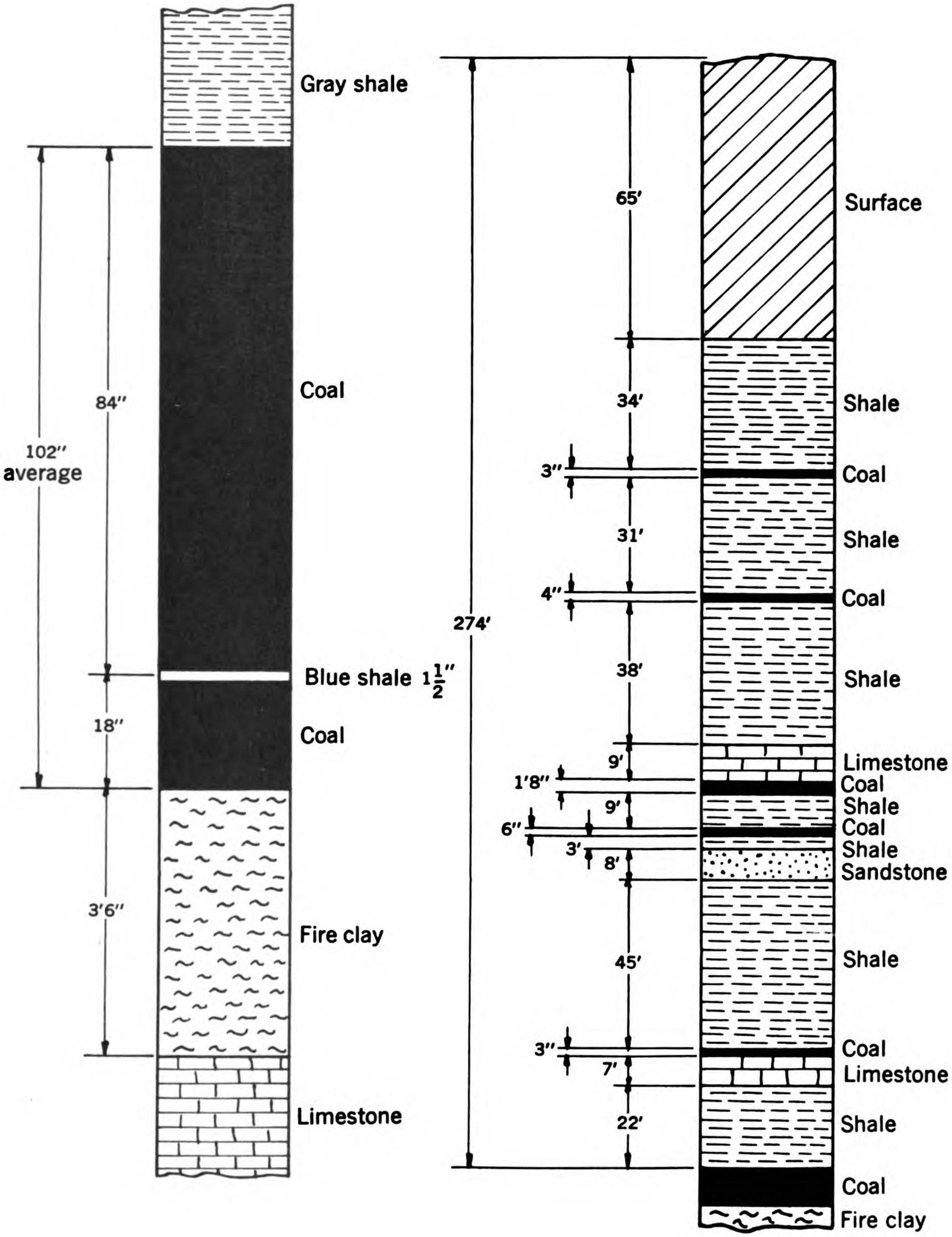

Figure 10. - Section of coal bed and overburden at mine 3.

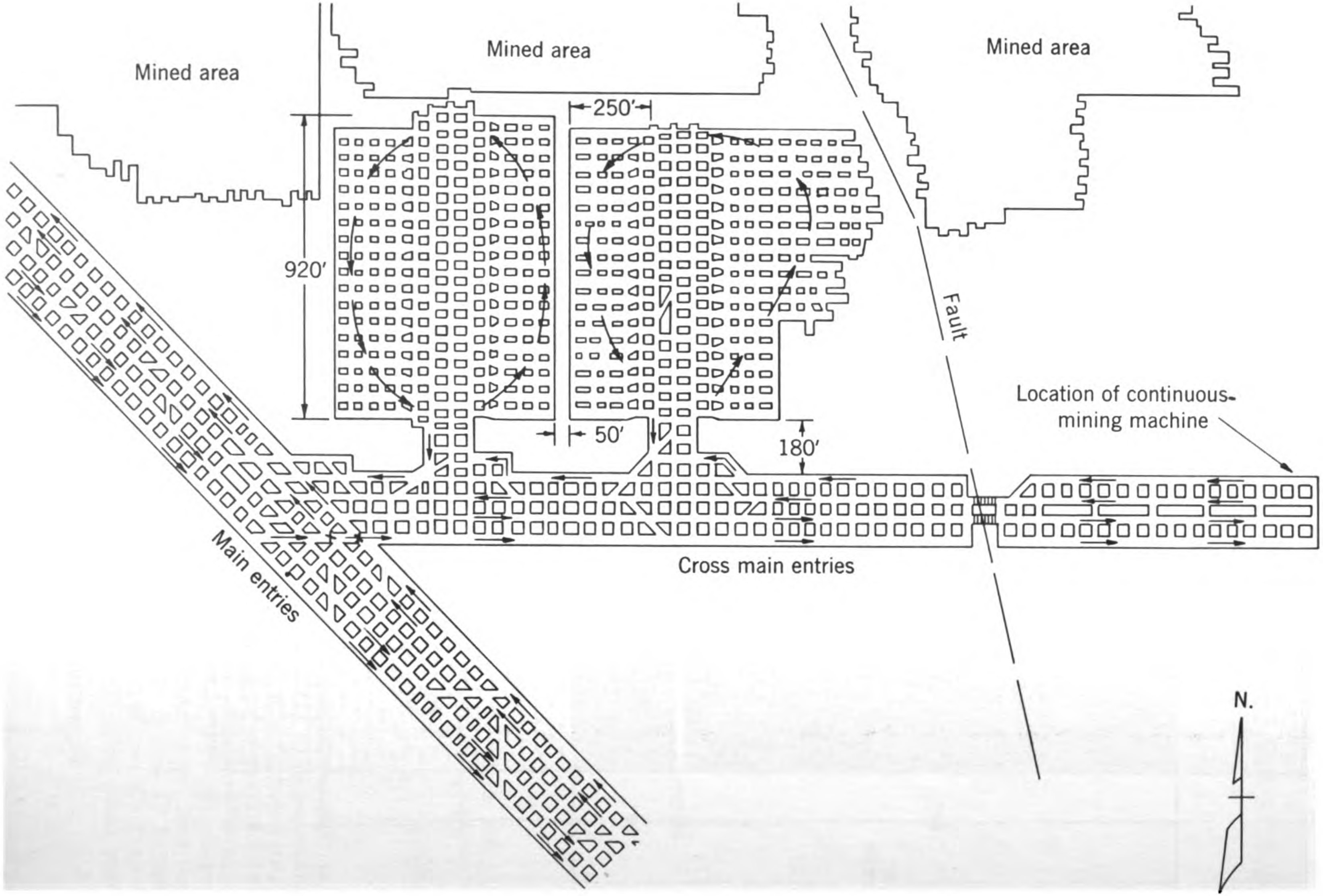

Figure 11. - Mining method at mine 3.

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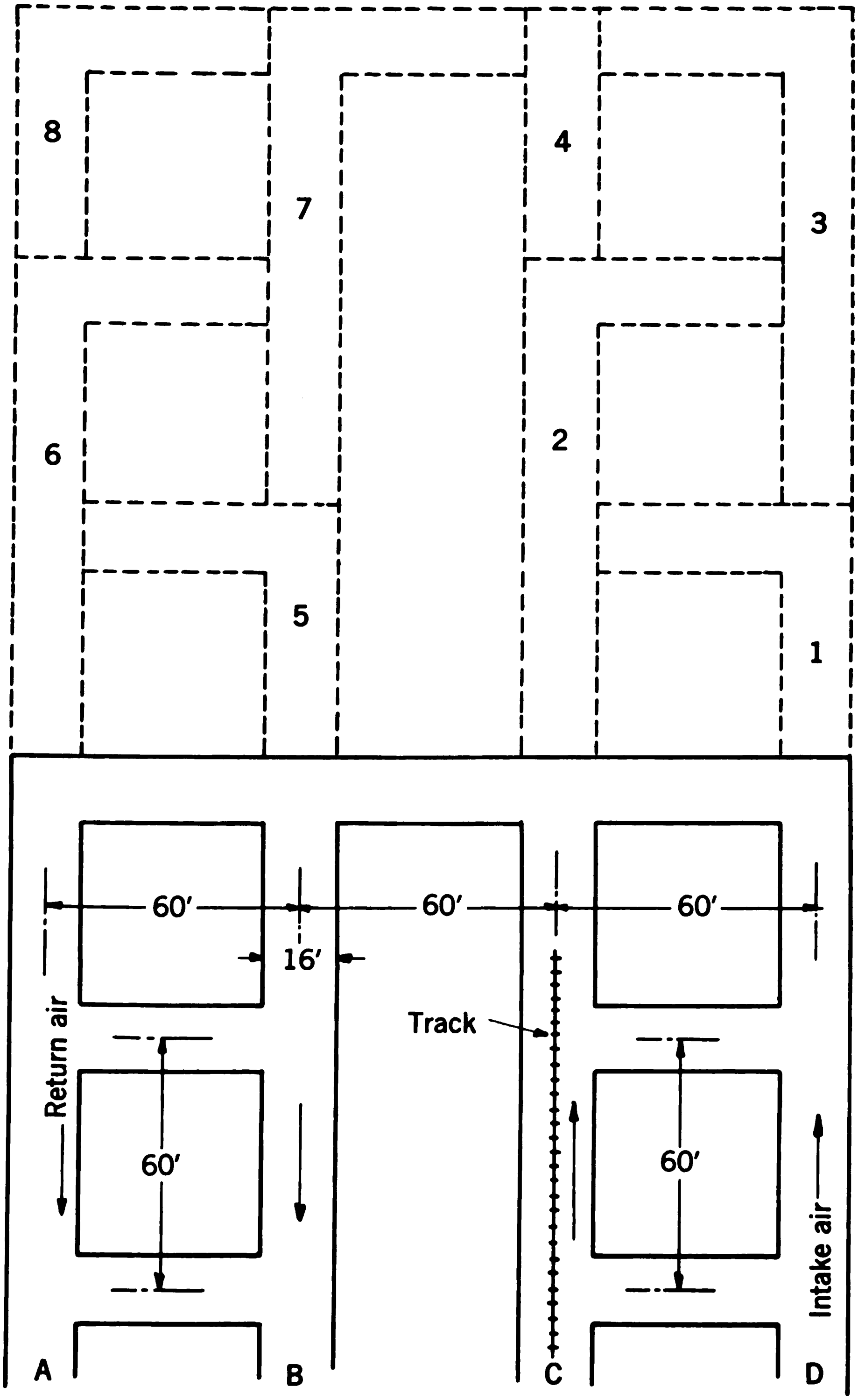

Figure 12. - Main-entry development at mine 3.

A continuous-mining unit comprises 6 men, 1 continuous-mining machine, and 2 cable-reel shuttle cars. One shuttle car is used behind the continuous-mining machine as a surge car, and the other shuttle car transports the coal to the unloading station. The shuttle car is equipped with an elevating conveyor, which discharges the coal into 10-ton-capacity, steel mine cars.

A continuous-mining crew consists of 6 men as follows:

Section foreman	1
Continuous-mining-machine operator	1
Continuous-mining-machine helper	1
Shuttle-car operator	1
Timberman (general laborer)	1
Electrician-mechanic	1
Total	6

Travel time at this mine is 1 hour 15 minutes; lunch time, 30 minutes, leaving 6 hours 15 minutes face time per shift. The average delay caused by mechanical failure is 43 minutes, 11.5 percent of face time. Other delays,such as maneuvering the continuous-mining machines, power failure, bit change, greasing, and waiting on empty cars amount to 1 hour 15 minutes, 20 percent of face time. Actual productive time is 4 hours 17 minutes, 68.5 percent of face time. All maintenance, moving, and other work to keep the continuous-mining machine operating is done on shift and between shifts by a mechanic.

Classification of Employees

Classification	Shift[1/] 1st	2d	3d	Total
Type A continuous-mining unit:				
Section foremen	1	1	-	2
Continuous-mining-machine operators	1	1	-	2
Continuous-mining-machine helpers	1	1	-	2
Shuttle-car operators	1	1	-	2
Timbermen (general laborers)	1	1	-	2
Electrician-mechanics	1	1	-	2
Total employees, continuous-mining unit	6	6	-	12
Total employees, mobile-loading units	89	84	-	173
Supervisory and inspection	3	2	1	6
Other underground employees	44	22	9	75
Total underground employees	142	114	10	266
Total surface employees	72	36	8	116
Total surface and underground employees	214	150	18	382

1/ 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 5:30 p.m. to 1:30 a.m.
3d shift - 11:30 p.m. to 7:30 a.m.

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Summary

	Continuous mining	Conventional mining
Percent of mine production	11.6	88.4
Hours per shift	8	8
Unit shifts per day	2	12
Average yield of clean coal ... percent	85	85
Average advance of continuous-mining machine per shift ... feet	65	-
Employees:		
In unit crews	12	173
Supervisory and other underground	9	72
Surface	13	103
Total charged to	34	348
Average daily production, raw coal ... tons	587	4,473
Average production, raw coal per unit per shift ... tons	293.5	373
Average production, raw coal per man per shift on unit ... tons	48.9	25.9
Average production, raw coal per underground man shift ... tons	28.0	18.3
Average production, raw coal per payroll man shift ... tons	17.3	12.9

Mine 4

Location	Illinois
Coal bed and thickness (fig. 13) ... inches	No. 6 - 102 (84 inches mined)
Thickness of overburden (fig. 13) ... feet	464
Production per day, raw coal ... tons	9,800
Total employees	700
Type A continuous-mining machines:	
Entry development	2
Mobile-loading units	12
Shifts per day	2
System of mining (fig. 14)	Room and pillar, pillars not extracted
Estimated recovery of coal in place ... percent	50
Mainline haulage	Locomotive

Mining method

Two type A continuous-mining machines, operated two unit shifts per day, are used to develop main and cross main entries. (See fig. 15.) The solid lines in entries A, B, C, and D represent the coal faces at the end of a complete cycle of operations; the broken line, the advance of the coal face at the end of the next complete cycle of operations. (Cuts 1 to 17.) Entries and crosscuts are driven 14 feet wide by the continuous-mining machine, which cuts 7 feet either side of center. The average advance of the continuous-mining machine in entries and crosscuts is 60 feet per shift. Entries are roof bolted on 3-foot centers with 3/4-inch-diameter bolts (expansion-shell type) 5 feet long, set against 6- by 6- by 3/8-inch steel plates. Roof bolting is done on the first, second, and third shifts.

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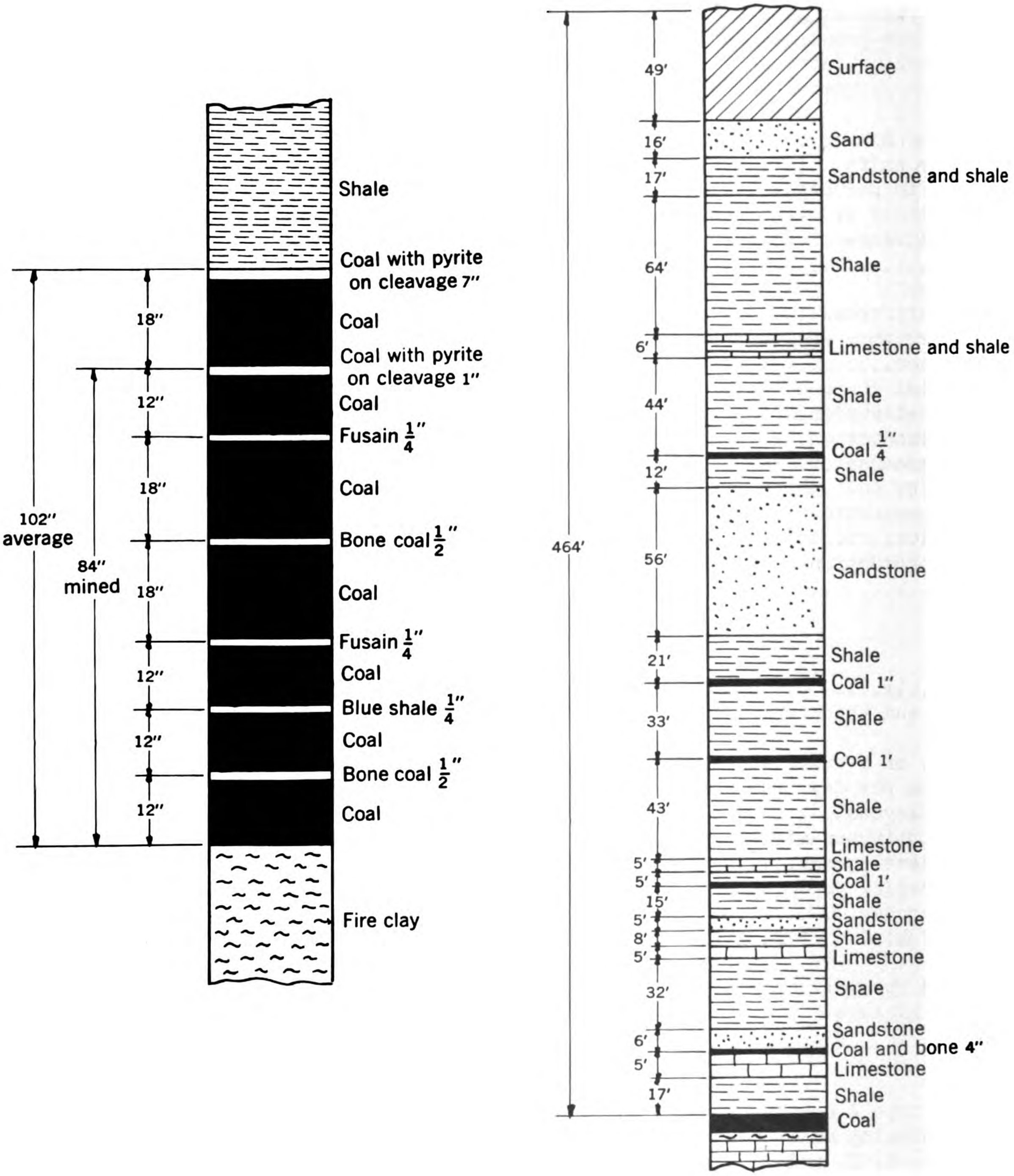

Figure 13. - Section of coal bed and overburden at mine 4.

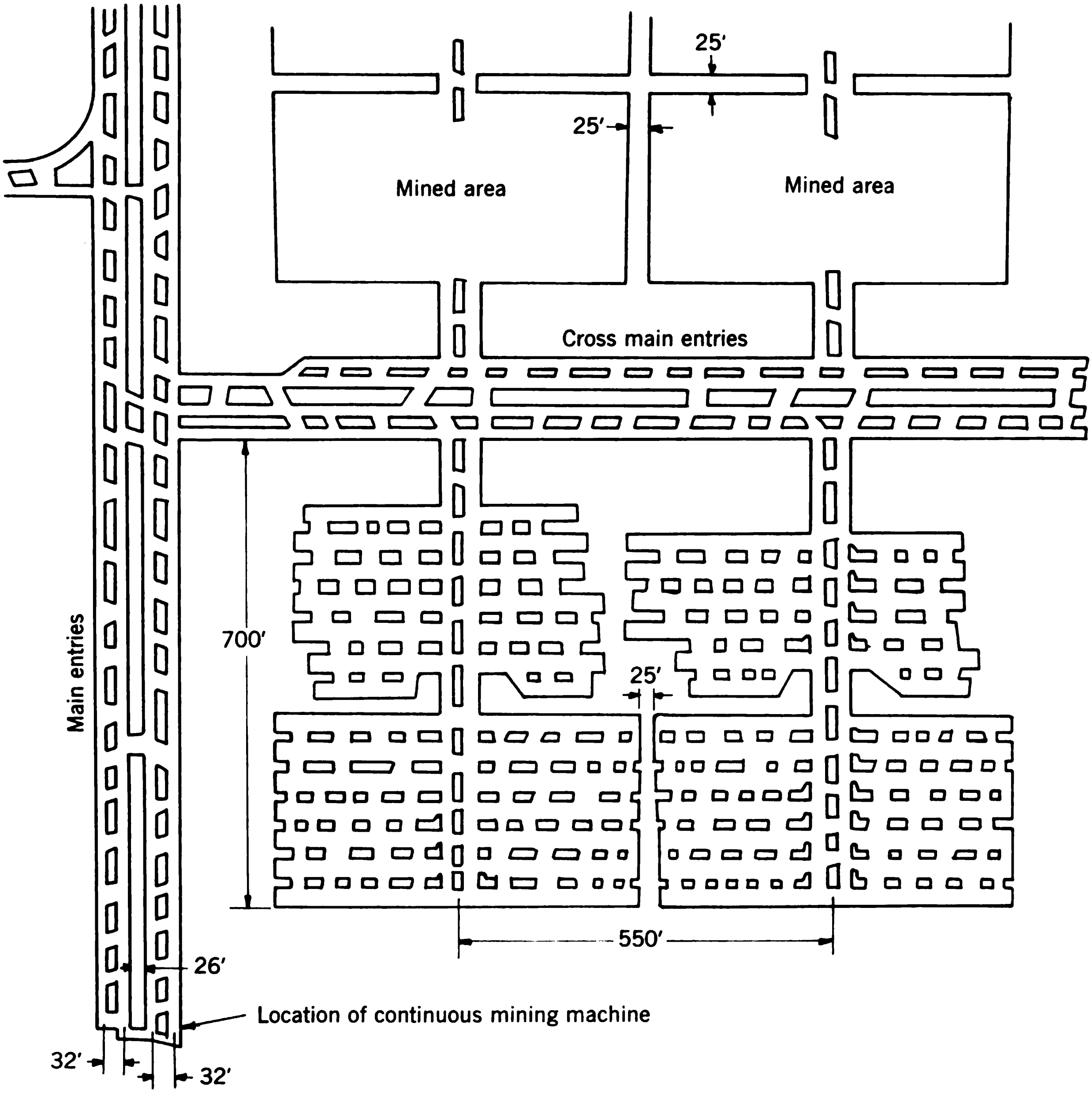

Figure 14. - Mining method at mine 4.

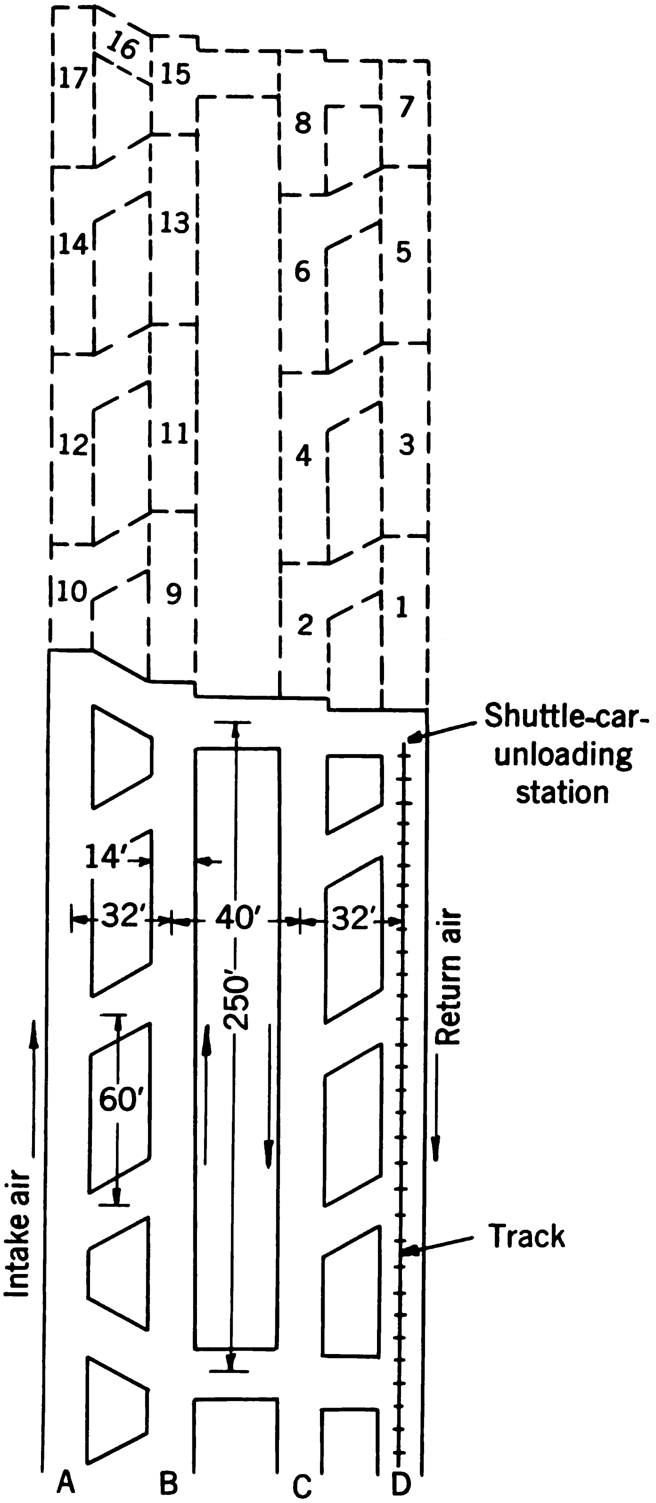

Figure 15. - Main-entry development at mine 4.

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A continuous-mining unit comprises 4-1/2 men, 1 continuous-mining machine, and 2 cable-reel shuttle cars. One shuttle car is used behind the continuous-mining machine as a surge car, and the other shuttle car transports the coal to the unloading station. The shuttle car is equipped with an elevating conveyor, which discharges the coal into 7-ton-capacity steel mine cars.

A continuous-mining crew consists of 4-1/2 men as follows:

Section foreman..................................	1/4
Continuous-mining-machine operator................	1
Continuous-mining-machine helper..................	1
Shuttle-car operator..............................	1
Motorman..	1
Electrician-mechanic..............................	1/4
Total...	4-1/2

Travel time at this mine is 40 minutes; lunch time, 30 minutes; leaving 6 hours 50 minutes face time per shift. The average delay caused by mechanical failure is 1 hour 30 minutes, 22 percent of face time. Other delays, such as maneuvering the continuous-mining machine, power failure, bit change, greasing, and waiting on empty cars amount to 30 minutes, 7.3 percent of face time. Actual productive time is 4 hours 50 minutes, 70.7 percent of face time. All maintenance, moving, and other work necessary to keep the continuous-mining machine operating is done on shift, when required, and on the second shift by the maintenance unit.

Classification of Employees

Classification	Shift[1/] 1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen..................................	1/2	-	-	1/2
Continuous-mining-machine operators...............	2	-	-	2
Continuous-mining-machine helpers.................	2	-	-	2
Shuttle-car operators.............................	2	-	-	2
Motormen..	2	-	-	2
Electrician-mechanic..............................	1/2	-	-	1/2
Total employees, continuous-mining units.........	9	-	-	9
Total employees, mobile-loading units............	116	116	-	232
Supervisory and inspection........................	20	20	2	42
Other underground employees.......................	96	96	40	232
Total underground employees......................	241	232	42	515
Total surface employees..........................	100	79	6	185
Total surface and underground employees........	341	311	48	700

[1/] 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 5:00 p.m. to 1:00 a.m.
3d shift - 10:00 p.m. to 6:00 a.m.

Summary

	Continuous mining	Conventional mining
Percent of mine production	5.7	94.3
Hours per shift	8	8
Unit shifts per day	2	24
Average yield of clean coal.................percent	90	90
Average advance of continuous-mining machine per shift.................feet	60	-
Employees:		
In unit crews	9	232
Supervisory and other underground	15	259
Surface	10	175
Total charged to	34	666
Average daily production, raw coal.............tons	556	9,244
Average production, raw coal per unit per shift.............tons	278	385
Average production, raw coal per man per shift on unit.............tons	61.8	39.8
Average production, raw coal per underground man shift.............tons	23.2	18.8
Average production, raw coal per payroll man shift.............tons	16.1	13.9

Mine 5

Location	Kentucky
Coal bed and thickness (fig. 16).............inches	Lower Elkhorn - 60 (48 inches mined)
Thickness of overburden (fig. 16)..............feet	250
Production per day, raw coal..................tons	1,200
Total employees	88
Type A continuous-mining machines:	
Entry development	4
Shifts per day	2
System of mining (fig. 17)	Block, pillars extracted
Estimated recovery of coal in place,........percent	30-inch belt

Mining Method

Four type A continuous-mining machines, operated eight unit shifts per day, are used to develop main and panel entries. The block system of mining is followed, and pillars are extracted. Main entries are driven in sets of 7 and 9 and panel entries in sets of 5. All entries are 16 feet wide on 60-foot centers. Crosscuts, 16 feet wide on 80-foot centers, are turned 60° to the entries. Sets of panel entries are driven on 600-foot centers to the outcrop. Rooms, 16 feet wide on 80-foot centers, are turned 60° to the entries. Room crosscuts are turned 60° to the rooms and are 16 feet wide on 60-foot centers. The 64- by 44-foot pillars, which remain after development, are extracted on retreat by either the open-end or pocket-and-fender method. The section foreman chooses the method of extraction.

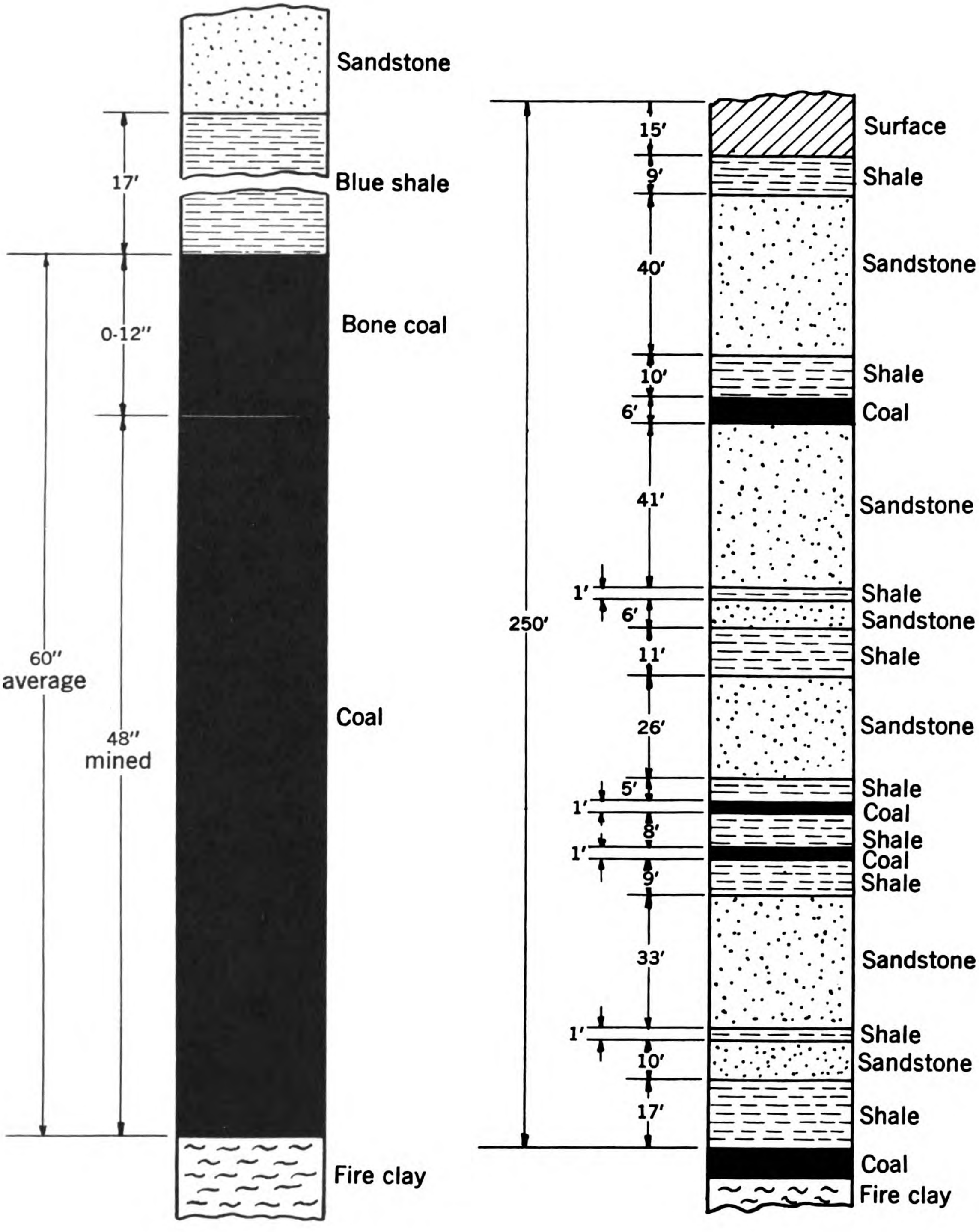

Figure 16. - Section of coal bed and overburden at mine 5.

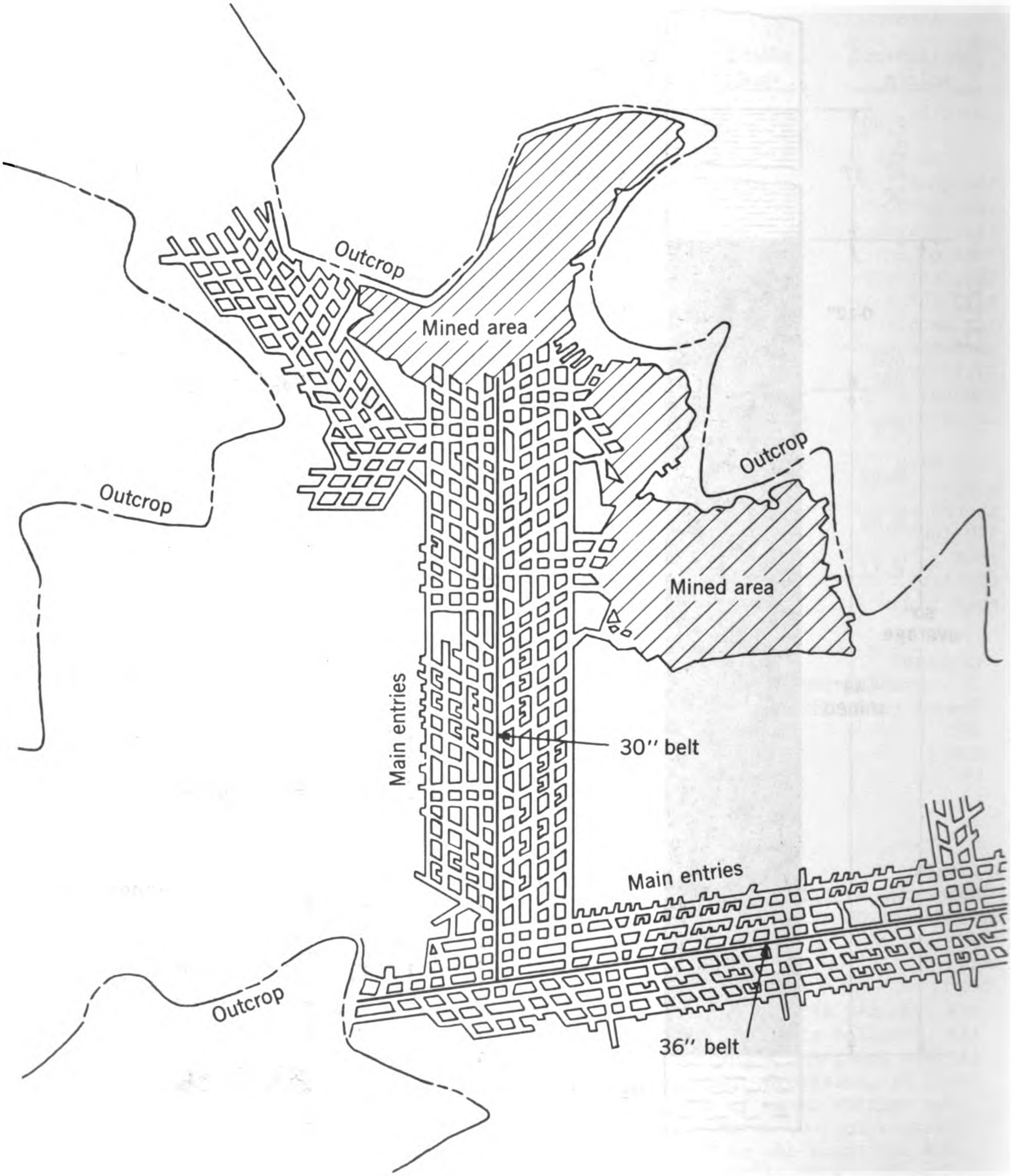

Figure 17. - Mining method at mine 5.

A continuous-mining unit comprises 6-1/2 men, 1 continuous-mining machine, 1 pneumatic roof drill, and 1 pneumatic wrench. In addition, 2 of the continuous-mining units each have 2 shuttle cars and 1 shaking conveyor to transport mined coal from the continuous-mining machine. The other 2 units each have twenty-two 18-foot portable conveyors to transport the coal.

In the shuttle-car section, the continuous-mining machine loads directly into the shuttle cars, which discharge onto the shaking conveyor. (See fig. 18.) The shaking conveyor, which can be extended to about 200 feet, discharges onto a 30-inch belt conveyor in the middle entry. The belt is extended every 3 crosscuts, or 240 feet of entry advance. In all entry development, the middle 3 entries are driven 240 feet ahead; then the outer entries are driven the same distance. Cuts A-1 to A-15 and B-1 to B-7, figure 18, show the sequence of cuts of the two continuous-mining machines. In the portable conveyor section, the mining machine loads onto a portable conveyor line, which discharges onto the 30-inch belt conveyor. (See fig. 19.) Twenty-two units, with an effective length of 17 feet per unit, allow the continuous-mining machine an advance of 374 feet beyond the belt conveyor. The belt is extended every 240 feet of advance.

With the exception of the breaker posts used in pillar extraction, all roof is supported by roof bolts. Three rows of 3/4-inch-diameter roof bolts (42 inches long in the center row and 36 inches long in the outer rows) are set against 6- by 6- by 3/8-inch steel plates on 4-foot centers. The operator does not work under unbolted roof. When it is necessary to set additional roof bolts to protect the operator, the continuous-mining machine is trammed back from the face and stopped while the roof is bolted. An average of 2-1/2 hours per shift is required for roof bolting.

A continuous-mining crew consists of 6-1/2 men as follows:

Section foreman..................................	1
Continuous-mining-machine operator...............	1
Shuttle-car operators or conveyor men............	2
Timbermen (roof bolters).........................	2
Electrician-mechanic.............................	1/2
Total..	6-1/2

Travel time at this mine is 30 minutes. The 30-minute lunch time is alternated so production is not stopped; leaving a total of 7 hours 30 minutes face time per shift. The average delay is 2 hours 48 minutes per shift, 37 percent of face time. Of this delay time, 2 hours 30 minutes, 90 percent, is for roof bolting, and 18 minutes, 10 percent, for all other delays. Actual productive time is 4 hours 42 minutes, 63 percent of face time. Maintenance and repair are done on shift by a mechanic and, if necessary, also on the third shift.

Classification of Employees

Classification	Shift[1]			Total
	1st	2d	3d	
Type A continuous-mining units:				
Section foremen..................................	4	4	-	8
Continuous-mining-machine operators..............	4	4	-	8
Shuttle-car operators............................	4	4	-	8
Conveyor men.....................................	4	4	-	8
Timbermen (roof bolters).........................	8	8	-	16
Electrician-mechanics............................	2	2	-	4
Total employees, continuous-mining units........	26	26	-	52

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[1] See footnote at end of tabulation on following page.

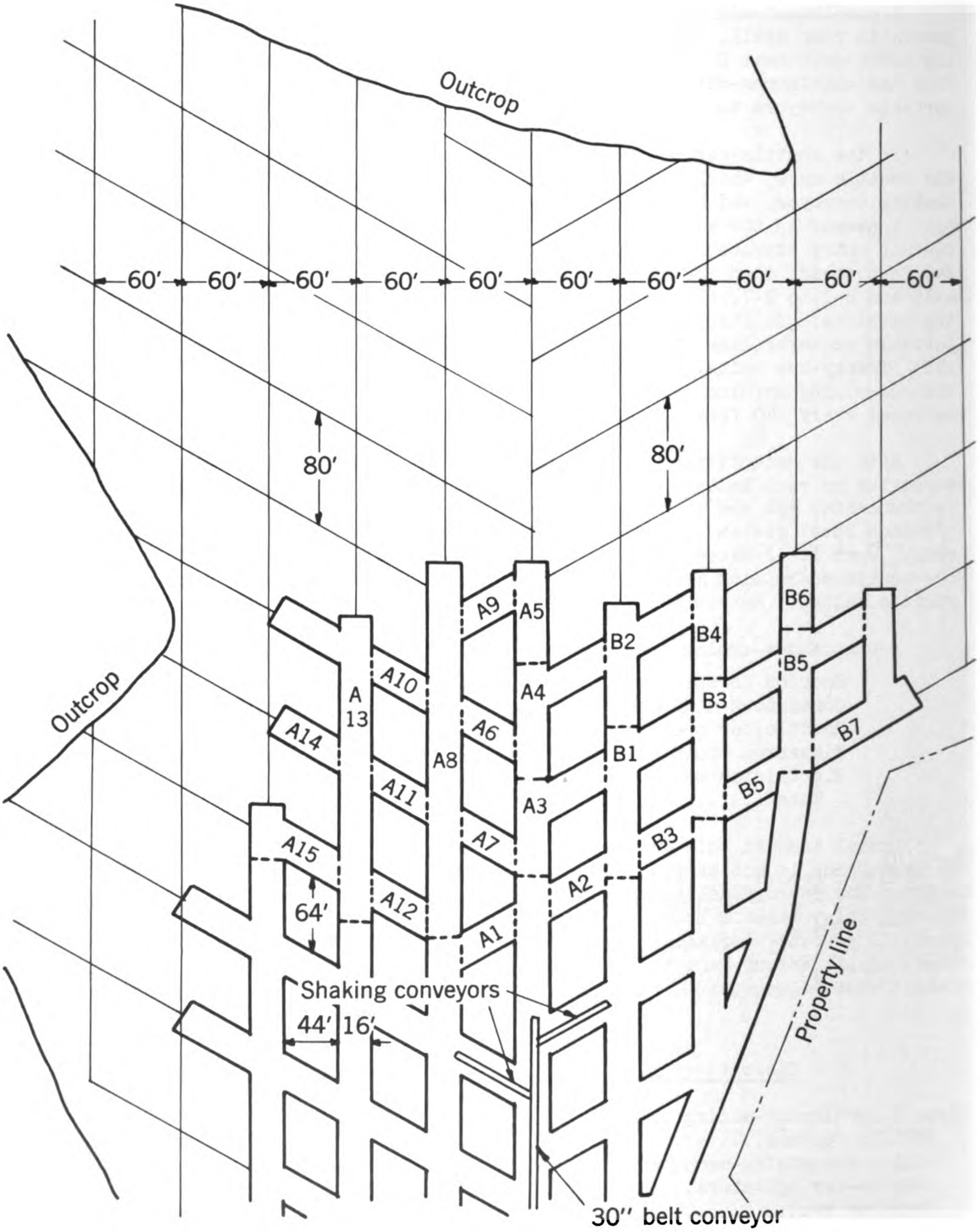

Figure 18. - Main-entry development at mine 5.

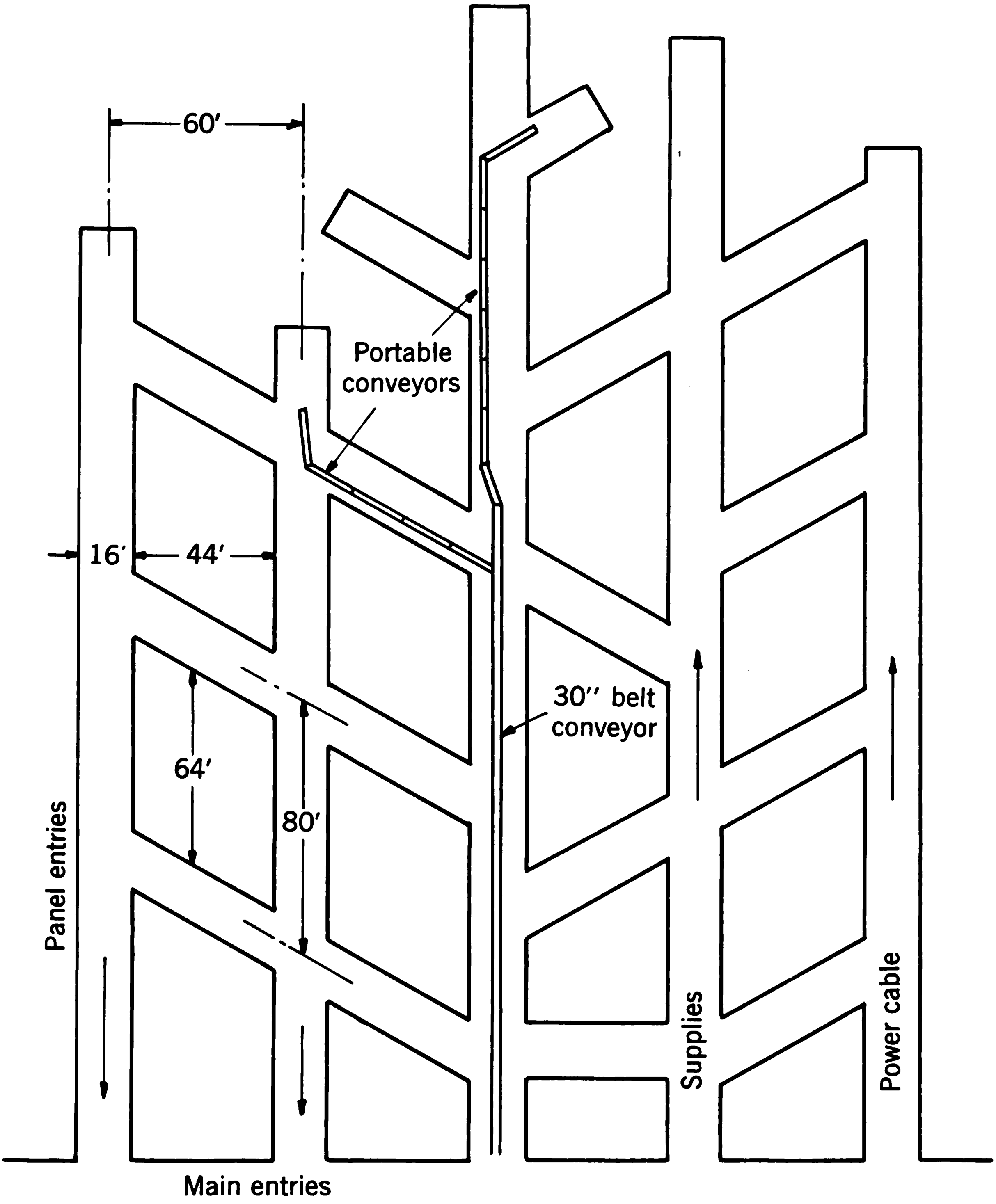

Figure 19. - Panel-entry development at mine 5.

Classification	Shift[1/] 1st	2d	3d	Total
Supervisory and inspection	2	2	-	4
Other underground employees	3	1	6	10
Total underground employees	31	29	6	66
Total surface employees	18	4	-	22
Total surface and underground employees	49	33	6	88

[1/] 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 4:00 p.m. to 12:00 p.m.
3d shift - 11:00 p.m. to 7:00 a.m.

Summary

	Continuous mining Shuttle-car unit		Continuous mining Portable conveyor unit	
Percent of mine production	53.3		46.7	
Hours per shift	8		8	
Unit shifts per day	4		4	
Average yield of clean coal...percent	100		100	
Average advance of continuous-mining machine per shift...feet	70		60	
Employees:				
In unit crews		26		26
Supervisory and other underground		7		7
Surface		11		11
Total charged to	44		44	
Average daily production, raw coal...tons	640		560	
Average production, raw coal per unit per shift...tons	160		140	
Average production, raw coal per man per shift on unit...tons	24.6		21.5	
Average production, raw coal per underground man shift...tons	19.4		17.0	
Average production, raw coal per payroll man shift...tons	14.6		12.7	

Mine 6

Location	Ohio
Coal bed and thickness (fig. 20)...inches	Pittsburgh No. 8 - 60 (57 inches mined)
Thickness of overburden...feet	350
Production per day, raw coal...tons	2,350
Total employees	223
Type A continuous-mining machine:	
Room mining	1
Mobile-loading units	8
Shifts per day	2
System of mining (fig. 21)	Room-and-pillar, pillars not extracted
Estimated recovery of coal in place...percent	65
Mainline haulage	Locomotive

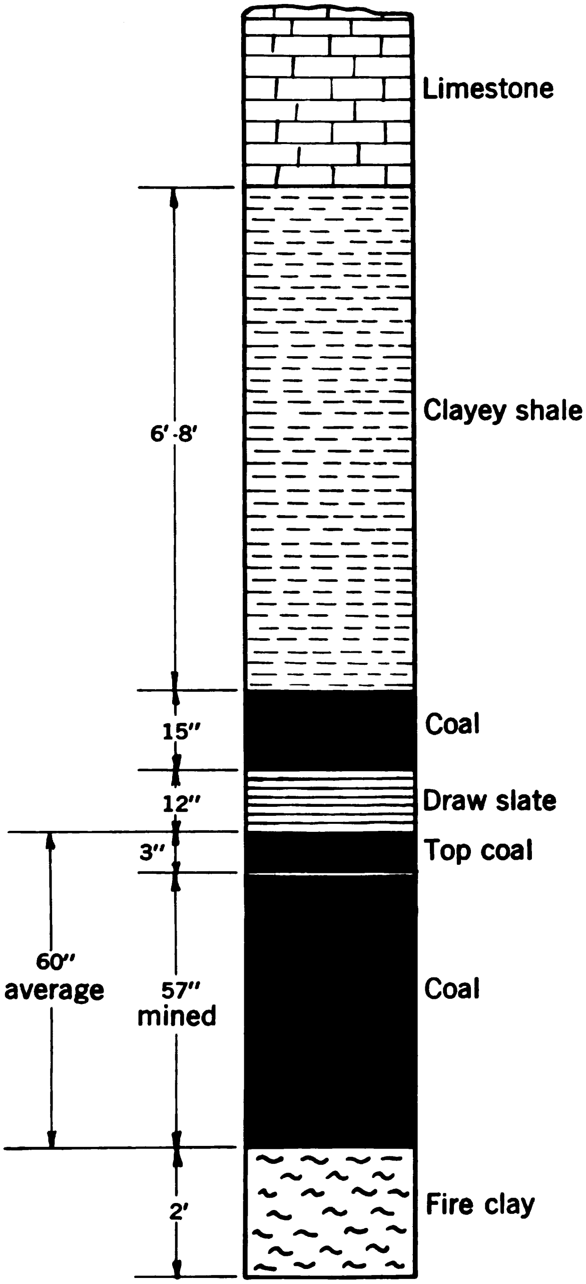

Figure 20. - Section of coal bed at mine 6.

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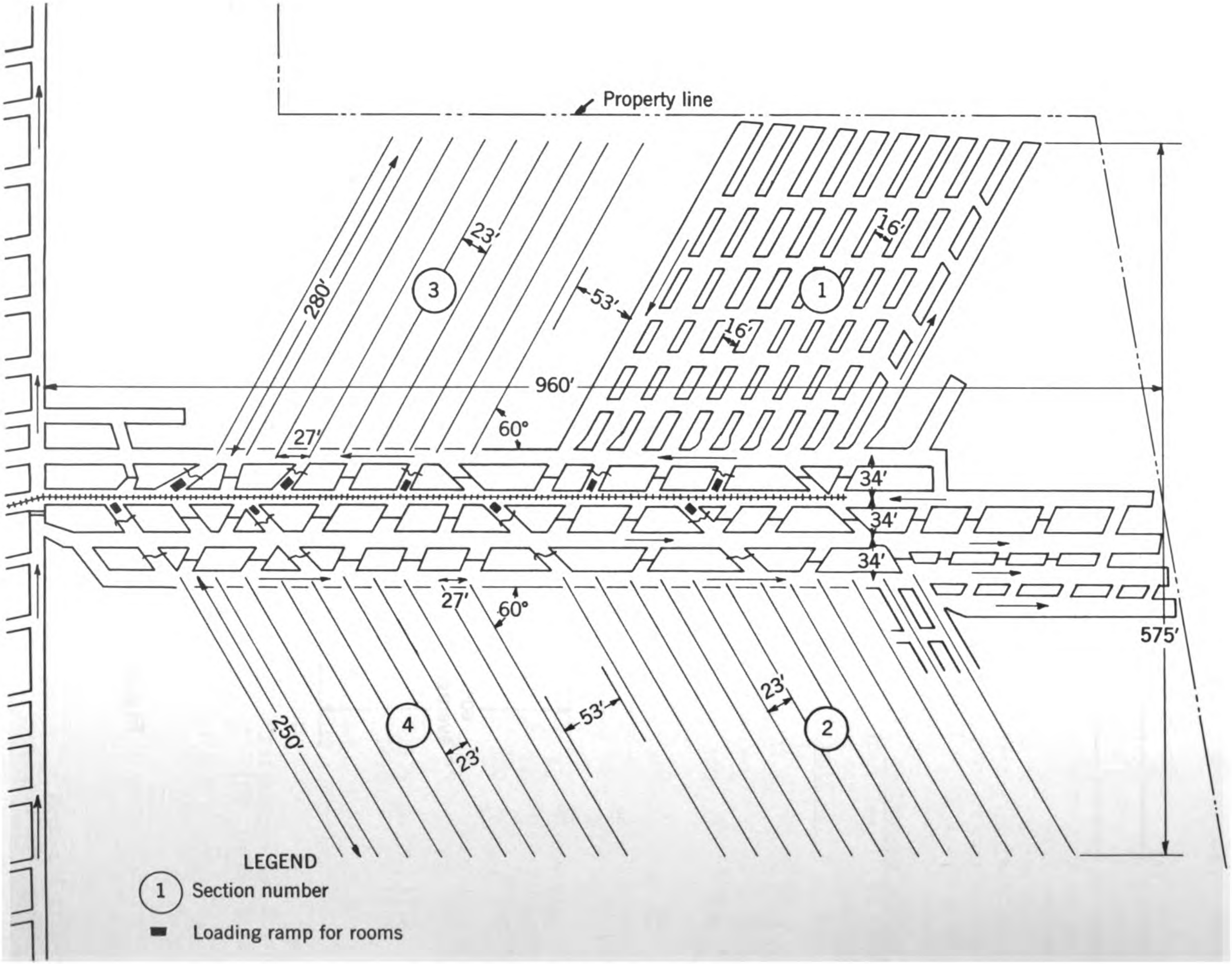

Figure 21. - Mining method at mine 6.

Mining Method

One type A continuous-mining machine, operated 2 unit shifts per day, is used to develop a set of 4 panel entries for a panel 960 feet long and 575 feet wide. (See fig. 21.) The entries are timbered with steel crossbars 10 feet long on 4-foot centers set on wood posts. Track with 40-pound rail is laid in the third inby entry as the entry advances. The same continuous-mining machine is used to develop rooms. Rooms are turned on 27-foot centers 60° from the panel entries. They are driven 16 feet wide and 250 or 280 feet deep. Crosscuts between the rooms are driven 16 feet wide on 45-foot centers and turned 60° from the room. The two inby rooms off the return-air course are mined simultaneously until completed. Adjacent rooms are mined one at a time until all of the rooms in section 1 of the panel are completed. Then the rooms in section 2 are mined similarly. A 53-foot pillar is left between adjacent sections. In mining with the continuous-mining machine 2 to 4 inches of top coal are left. Three- by 8-inch wood crossbars, 12 feet long and spaced on 4-foot centers, are set on posts to support the roof. These crossbars and posts are recovered when a room is completed.

A continuous-mining unit comprises 6-1/2 men, 1 continuous-mining machine, 1 loading machine, and 1 shuttle car. Coal from the continuous-mining machine is deposited on the floor and loaded with the loading machine into the shuttle car. This permits the continuous-mining machine to be operated without transportation delays.

The continuous-mining machine is crawler-mounted and moves along the center of the room cutting a 16-foot face. The average advance of the continuous-mining machine is 45 feet per shift.

Crossbars and posts are kept at least 3 feet in advance of the continuous-mining-machine operator. One shuttle car transports the coal from the mobile-loading machine behind the continuous-mining machine and discharges it into 5-1/2-ton-capacity, steel, drop-bottom mine cars at the unloading station. (See fig. 21.) The unloading station consists of a wood ramp in a crosscut that has been top brushed and timbered.

A continuous-mining crew consists of 6-1/2 men as follows:

Section foreman..................................	1/2
Continuous-mining machine operator...............	1
Loading-machine operator.........................	1
Shuttle-car operator.............................	1
Timberman..	1
Unloading-station operator.......................	1
Electrician-mechanic.............................	1
Total..	6-1/2

Travel time at this mine is 1 hour 20 minutes; lunch time, 30 minutes; leaving 6 hours 10 minutes face time per shift. The average delay caused by mechanical failure is 1 hour, 16.2 percent of face time. Other delays, such as maneuvering the continuous-mining machine, power failure, and timbering, amount to 5 minutes, 1.4 percent of face time. Actual productive time is 5 hours 5 minutes, 82.4 percent of face time. All repairs, greasing, moving, and other necessary work to keep the continuous-mining machine operating are done on the third shift by a mechanic and helper.

Classification of Employees

Classification	Shift[1/] 1st	2d	3d	Total
Type A continuous-mining unit:				
Section foreman	1/2	1/2	-	1
Continuous-mining-machine operators	1	1	-	2
Loading-machine operators	1	1	-	2
Shuttle-car operators	1	1	-	2
Timbermen	1	1	-	2
Unloading-station operators	1	1	-	2
Electrician-mechanics	-	-	2	2
Total employees, continuous-mining unit	5-1/2	5-1/2	2	13
Total employees, mobile-loading units	68	35	12	115
Supervisory and inspection	8	3	2	13
Other underground employees	38	6	3	47
Total underground employees	119-1/2	49-1/2	19	188
Total surface employees	22	10	3	35
Total surface and underground employees	141-1/2	59-1/2	22	223

1/ 1st shift - 7:15 a.m. to 3:15 p.m.
2d shift - 3:30 p.m. to 11:30 p.m.
3d shift - 11:00 p.m. to 7:00 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	17		83	
Hours per shift	8		8	
Unit shifts per day	2		15	
Average yield of clean coal ... percent	92		70	
Average advance of continuous-mining machine per shift ... feet	45		-	
Employees:				
In unit crews		13		115
Supervisory and other underground		11		49
Surface		6		29
Total charged to	30		193	
Average daily production, raw coal ... tons	399.5		1,950.5	
Average production, raw coal per unit per shift ... tons	199.7		130	
Average production, raw coal per man per shift on unit ... tons	30.7		17.0	
Average production, raw coal per underground man shift ... tons	16.6		11.9	
Average production, raw coal per payroll man shift ... tons	13.3		10.1	

Mine 7

Location..	Pennsylvania
Coal bed and thickness (fig. 22)....................inches	Lower Kittanning - 50 (42 inches mined)
Thickness of overburden (fig. 22)....................feet	500
Production per day, raw coal..........................tons	2,857
Total employees..	314
Type A continuous-mining machines:	
Room mining..	2
Mobile-loading units......................................	6
Shifts per day..	3
System of mining (fig. 23)................................	Room and pillar, pillars not extracted
Estimated recovery of coal in place................percent	55
Mainline haulage..	Locomotive

Mining Method

Two type A continuous-mining machines, operated six unit shifts per day, are used to mine rooms. Rooms are mined on retreat after the panel entries are advanced 1,850 feet and are turned at right angles to the outside panel entries. Rooms on one side of the panel are mined with a continuous-mining machine, and on the opposite side of the panel, rooms are mined with a mobile-loading machine. A 30-inch panel belt transports the coal to the main track entry and discharges into 10-ton mine cars. The plan for developing rooms is shown in figure 24. The solid line represents the completed mining in the rooms. The broken line represents the cycle of mining to complete a room and to mine crosscuts. (Cuts 1 to 6.) Rooms and crosscuts are driven 16 feet wide by the continuous-mining machine, which moves along the center of the place. The average advance of the continuous-mining machine is 51 feet per shift. Rooms are timbered on 4-foot centers with a line of wood posts set 3 or 4 feet from the inby rib.

A continuous-mining unit comprises 6 men, 1 continuous-mining machine, 2 cable-reel shuttle cars, and 1 panel belt. One shuttle car is used behind the continuous-mining machine as a surge car; the other shuttle car transports the coal from the surge car to the unloading station. The shuttle car is equipped with an elevating conveyor, which discharges the coal onto the 30-inch panel belt.

A continuous-mining crew consists of 6 men as follows:

Section foreman..............................	1/2
Continuous-mining-machine operator............	1
Continuous-mining-machine helper..............	1
Shuttle-car operators.........................	2
Car trimmer...................................	1/2
Electrician-mechanic..........................	1
Total.......................................	6

Travel time at this mine is 1 hour 40 minutes; lunch time, 30 minutes; leaving 5 hours 50 minutes face time per shift. The average delay caused by mechanical failure is 50 minutes, 14.3 percent of face time. Other delays such as maneuvering the continuous-mining machine, power failure, bit changes, greasing, delivery of supplies, rock dusting, and waiting on empty cars amount to 1 hour 48 minutes, 30.9 percent of face time. Actual productive time is 3 hours 12 minutes, 54.9 percent of

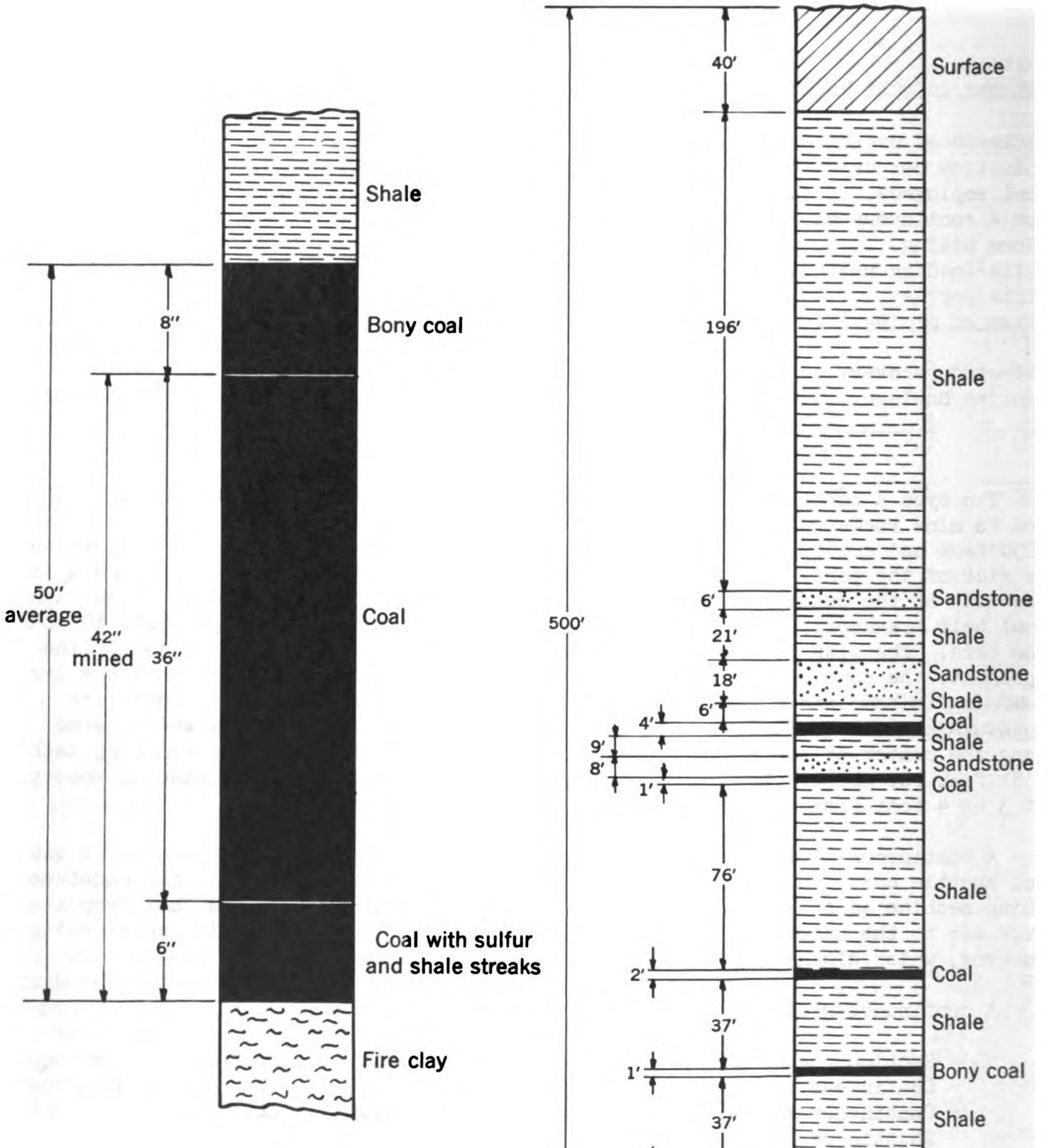

Figure 22. - Section of coal bed and overburden at mine 7.

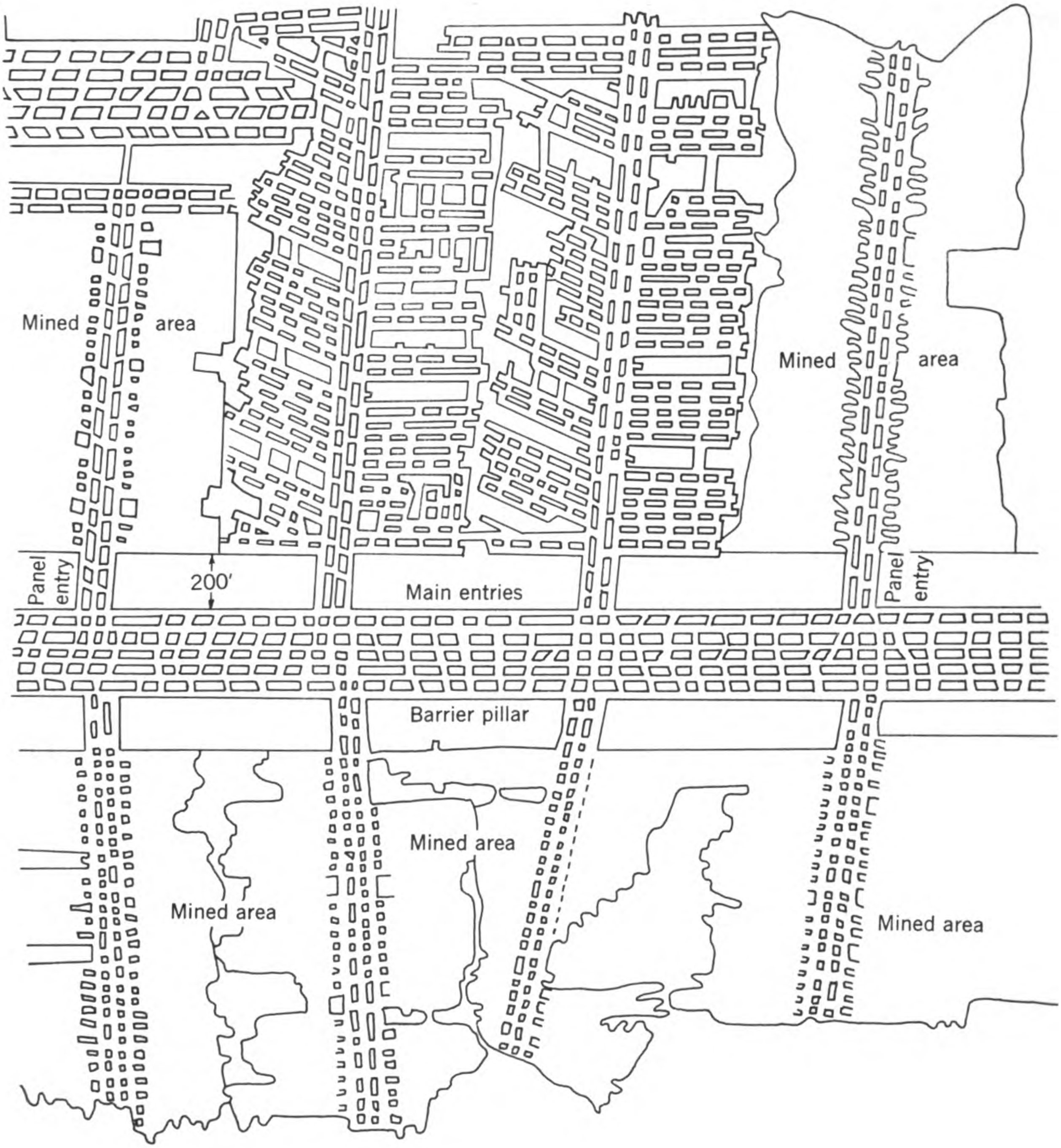

Figure 23. - Mining method at mine 7.

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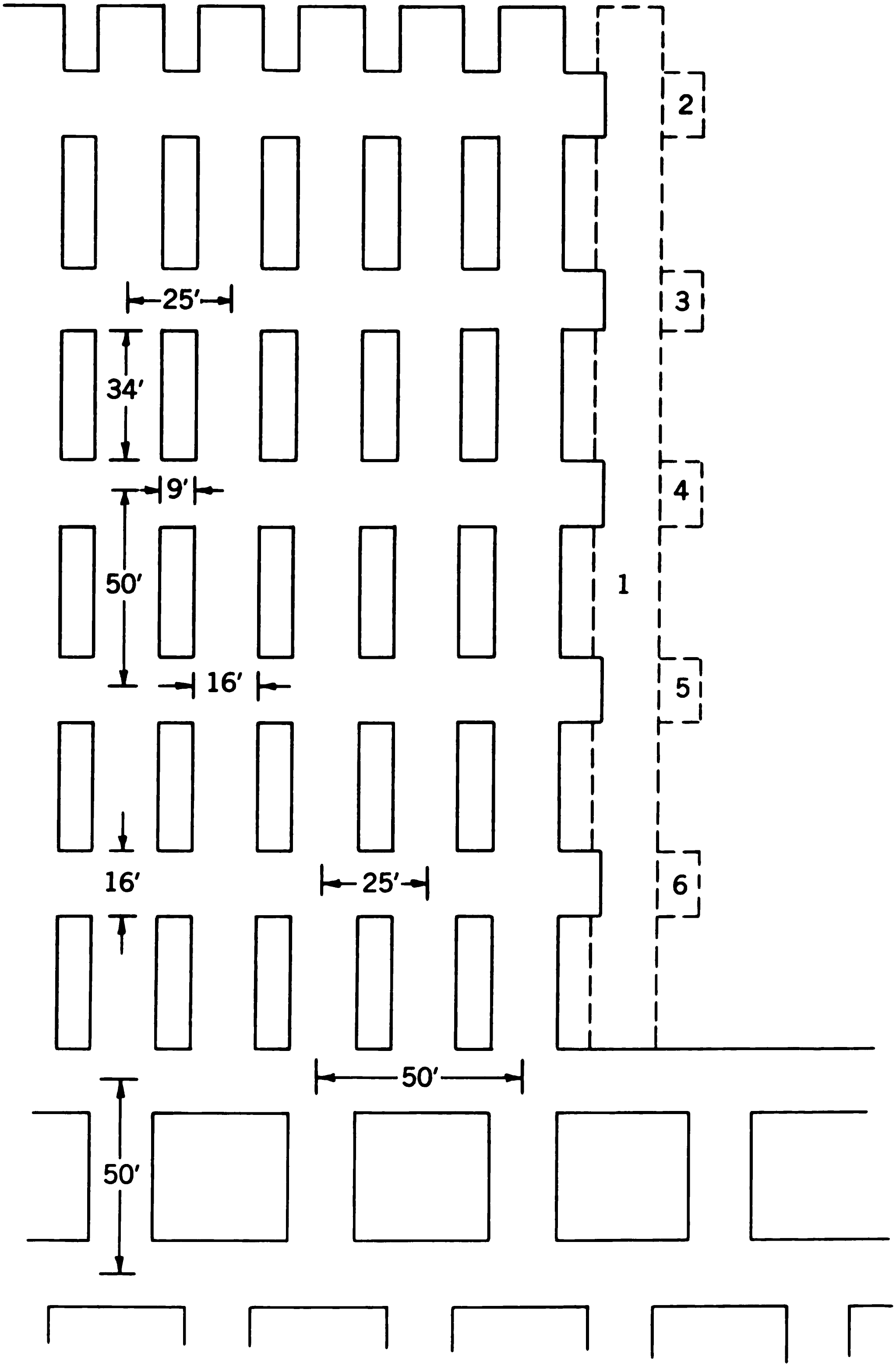

Figure 24. - Room mining at mine 7.

face time. All maintenance, moving, and other work necessary to keep the continuous-mining machine operating is done on shift and on the third shift, when required.

Classification of Employees

Classification	Shift[1] 1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	1	1	1	3
Continuous-mining-machine operators	2	2	2	6
Continuous-mining-machine helpers	2	2	2	6
Shuttle-car operators	4	4	4	12
Car trimmers	1	1	1	3
Electrician-mechanics	2	2	2	6
Total employees, continuous-mining units	12	12	12	36
Total employees, mobile-loading units	51	50	50	151
Supervisory and inspection	5	5	5	15
Other underground employees	20	20	19	59
Total underground employees	88	87	86	261
Total surface employees	26	14	13	53
Total surface and underground employees	114	101	99	314

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[1] 1st shift - 6:00 a.m. to 2:00 p.m.
2d shift - 12:30 p.m. to 8:30 p.m.
3d shift - 9:00 p.m. to 5:00 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	22		78	
Hours per shift	8		8	
Unit shifts per day	6		18	
Average yield of clean coal, percent	70		70	
Average advance of continuous-mining machine per shift, feet	51		-	
Employees:				
In unit crews		36		151
Supervisory and other underground		16		58
Surface		12		41
Total charged to	64		250	
Average daily production, raw coal, tons	628.5		2,228.5	
Average production, raw coal per unit per shift, tons	104.8		123.8	
Average production, raw coal per man per shift on unit, tons	17.5		14.8	
Average production, raw coal per underground man shift, tons	12.1		10.7	
Average production, raw coal per payroll man shift, tons	9.8		8.9	

Mine 8

Location..	Pennsylvania
Coal bed and thickness (fig. 25).....................inches	Upper Freeport - 42
Thickness of overburden (fig. 25)......................feet	334
Production per day, raw coal...........................tons	1,800
Total employees...	157
Type A continuous-mining machines:	
Room mining...	3
Mobile-loading unit...	1
Shifts per day..	3
System of mining (fig. 26)..................................	Room-and-pillar, pillars not extracted
Estimated recovery of coal in place................percent	63
Mainline haulage..	30-inch belt

Mining Method

Three type A continuous-mining machines, operated nine unit shifts per day, are used to develop rooms on both sides of a panel entry. The middle entry is equipped with a 30-inch belt, which transports the coal to the 30-inch main-entry belt. The plan for developing rooms is shown in figure 27. The solid line represents the completed mining in the rooms. The broken line represents the cycle of mining to complete a room and mine crosscuts on retreat. Rooms and crosscuts are driven 16 feet wide by the continuous-mining machine, which moves along the center of the place. The average advance of the continuous-mining machine is 56 feet per shift. Rooms are timbered on 4-foot centers with a row of wood posts set 4 feet from 1 rib.

A continuous-mining unit comprises 6 men, 1 continuous-mining machine, 1 mobile-loading machine, and 1 cable-reel shuttle car. The continuous-mining machine deposits the mined coal on the floor. This practice allows the continuous-mining machine to be operated with a minimum of shuttle-car-haulage delays. The mobile-loading machine reloads the coal into a 2-ton-capacity shuttle car, which transports the coal and discharges it onto the 30-inch belt. However, in 1 unit, 2 shuttle cars are used instead of 1 shuttle car and 1 mobile-loading unit.

A continuous-mining crew consists of 6 men as follows:

Section foreman..............................	1
Continuous-mining-machine operator...........	1
Continuous-mining-machine helper.............	1
Loading-machine operator.....................	1
Shuttle-car operator.........................	1
Electrician-mechanic.........................	1
Total....................................	6

Travel time at this mine is 30 minutes; lunch time, 30 minutes; leaving 7 hours face time per shift. The average delay caused by mechanical failure is 40 minutes, 9.5 percent of face time. Other delays, such as retracting or maneuvering the continuous-mining machine, power failure, and transportation delays, amount to 1 hour 5 minutes, 15.5 percent of face time. Actual productive time is 5 hours 15 minutes, 75 percent of face time. All maintenance, moving, and other work necessary to keep the continuous-mining machine operating is done by a mechanic on shift and on idle days.

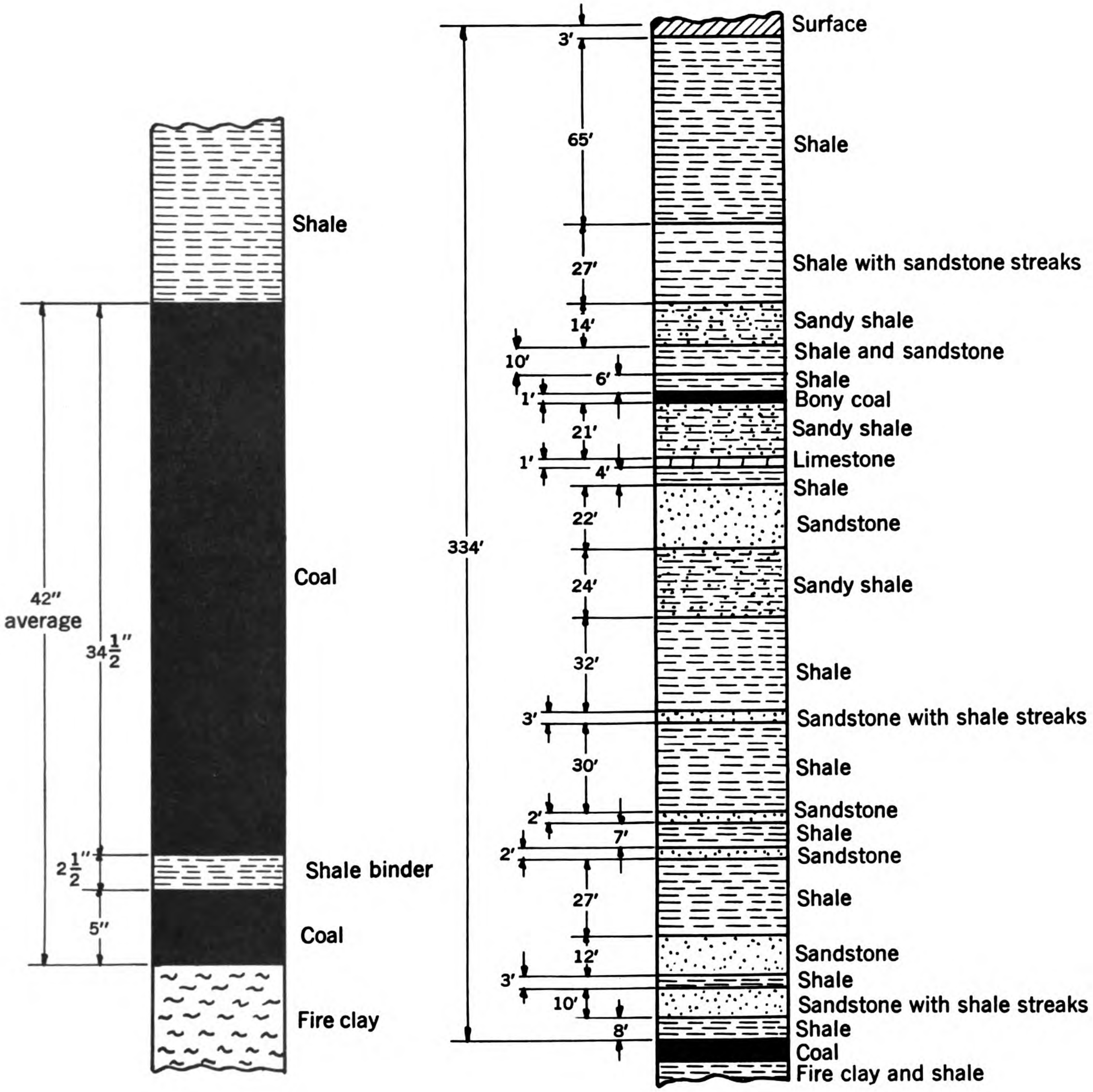

Figure 25. - Section of coal bed and overburden at mine 8.

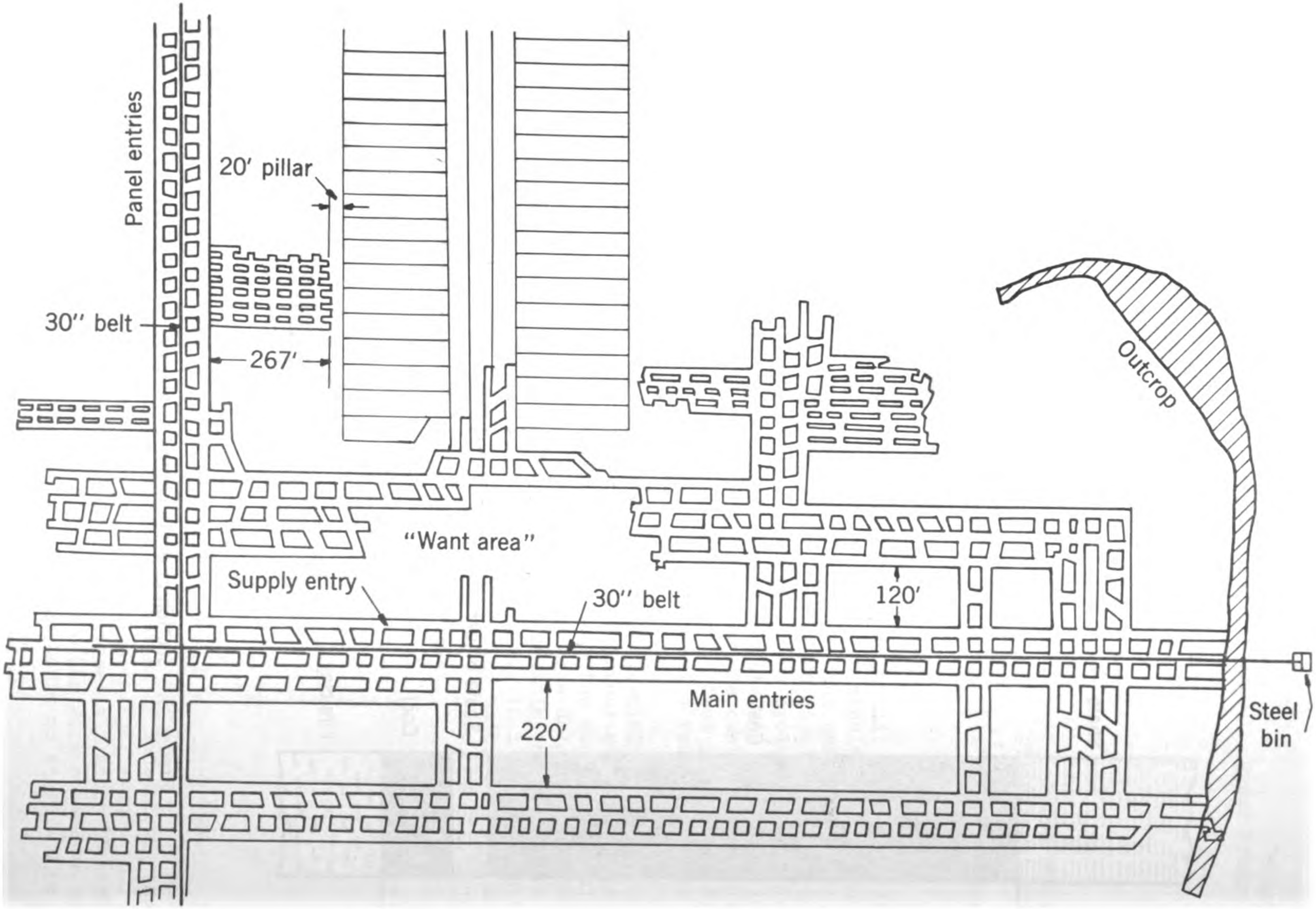

Figure 26. - Mining method at mine 8.

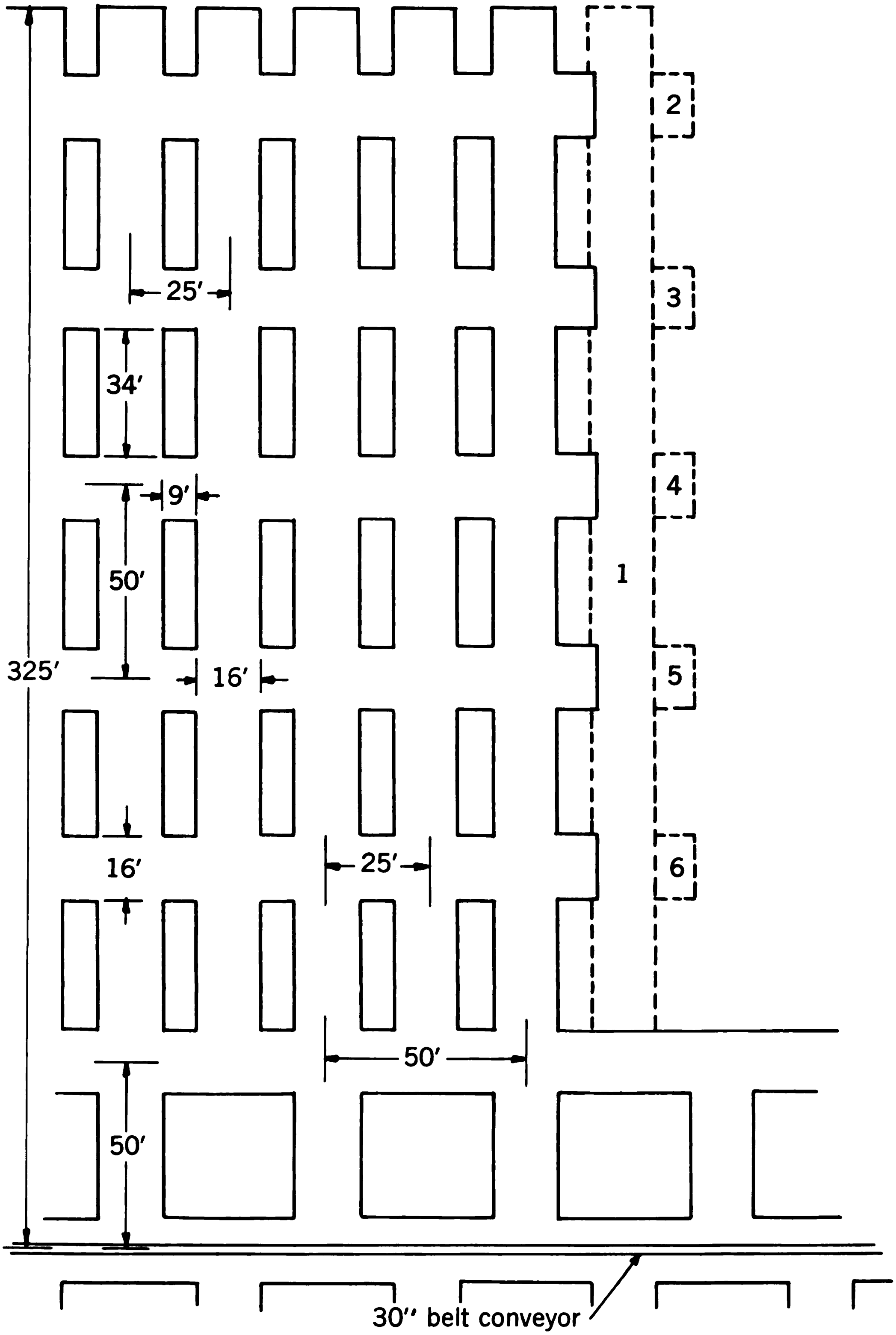

Figure 27. - Room mining at mine 8.

Classification of Employees

	Shift[1]			
Classification	1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	3	3	2	8
Continuous-mining-machine operators	3	3	3	9
Continuous-mining-machine helpers	3	3	3	9
Loading-machine operators	2	2	2	6
Shuttle-car operators	4	4	4	12
Electrician-mechanics	3	3	3	9
Total employees, continuous-mining units	18	18	17	53
Total employees, mobile-loading units	12	12	12	36
Supervisory and inspection	2	1	-	3
Other underground employees	13	1	-	14
Total underground employees	45	32	29	106
Total surface employees	19	16	16	51
Total surface and underground employees	64	48	45	157

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[1] 1st shift - 6:30 a.m. to 2:30 p.m.
2d shift - 2:30 p.m. to 10:30 p.m.
3d shift - 10:30 p.m. to 6:30 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	69.5		30.5	
Hours per shift	8		8	
Unit shifts per day	9		3	
Average yield of clean coal...percent	80		80	
Average advance of continuous-mining machine per shift...feet	56		-	
Employees:				
In unit crews		53		36
Supervisory and other underground		12		5
Surface		35		16
Total charged to	100		57	
Average daily production, raw coal...tons	1,251		549	
Average production, raw coal per unit per shift...tons	139		183	
Average production, raw coal per man per shift on unit...tons	23.6		15.3	
Average production, raw coal per underground man shift...tons	19.3		13.4	
Average production, raw coal per payroll man shift...tons	12.5		9.6	

Mine 9

Location	Pennsylvania
Coal bed and thickness (fig. 28)...inches	Lower Kittanning - 41
Thickness of overburden (fig. 28)...feet	445
Production per day, raw coal...tons	4,058
Total employees	843
Type B continuous-mining machines:	
Entry development	1
Room mining	1
Mobile-loading units	8
Hand-loading units	4
Shifts per day	3
System of mining (fig. 29)	Room-and-pillar, pillars extracted
Estimated recovery of coal in place...percent	93
Mainline haulage	Locomotive

Mining Method

Two type B continuous-mining machines, operated six unit shifts per day, are used to mine rooms, extract room pillars, and develop entries. The plan followed in mining rooms and extracting pillars with the continuous-mining machine is shown in figure 30. The cuts comprising a complete mining cycle are indicated by the broken lines. These cuts are mined in the sequence indicated by numbers 1 to 23, inclusive. The solid lines show the coal faces at the beginning of the mining cycle. Before the pillars between rooms E and F are mined, room G is driven to provide an escapeway. A row of room pillars is left around the panel to provide a bleeder. (See fig. 29.) The panel-entry pillars and the room stumps are extracted by a mobile-loading unit as the rooms are retreated by the continuous-mining machine. The panel belt is retracted in 100-foot sections. The average advance of the continuous-mining machine is 100 feet per shift.

Rooms, entries, and crosscuts are driven 17 feet wide by making alternate cuts 9 feet 6 inches and 7 feet 6 inches wide. (See fig. 31.) Four-inch diameter wood posts on 4-foot centers are set along the center of a completed cut. These posts are reset when the alternate cut is completed and then reset along the right rib as the continuous-mining machine advances. (See fig. 31.) Entries and crosscuts are timbered on 4-foot centers using 4-inch-diameter wood posts set 3 feet from the right rib. On pillar extraction, wood cribs are set along the gob side of each lift. These cribs are recovered and moved forward with each successive lift. At the time of this study, the continuous-mining section was not being roof bolted.

A continuous-mining unit comprises 6-1/2 men, 1 continuous-mining machine, 2 cable-reel shuttle cars, and one 30-inch belt. The continuous-mining machine loads the coal into 3-ton-capacity shuttle cars, which transport the coal to the belt conveyor in the panel entry. Mine cars, 2.4-ton capacity, are spotted by the boom man at the discharge end of the belt conveyor with a remote-controlled car haul.

A continuous-mining crew consists of 6-1/2 men as follows:

Section foreman	1/2
Continuous-mining-machine operator	1
Utility man	1
Shuttle-car operators	2

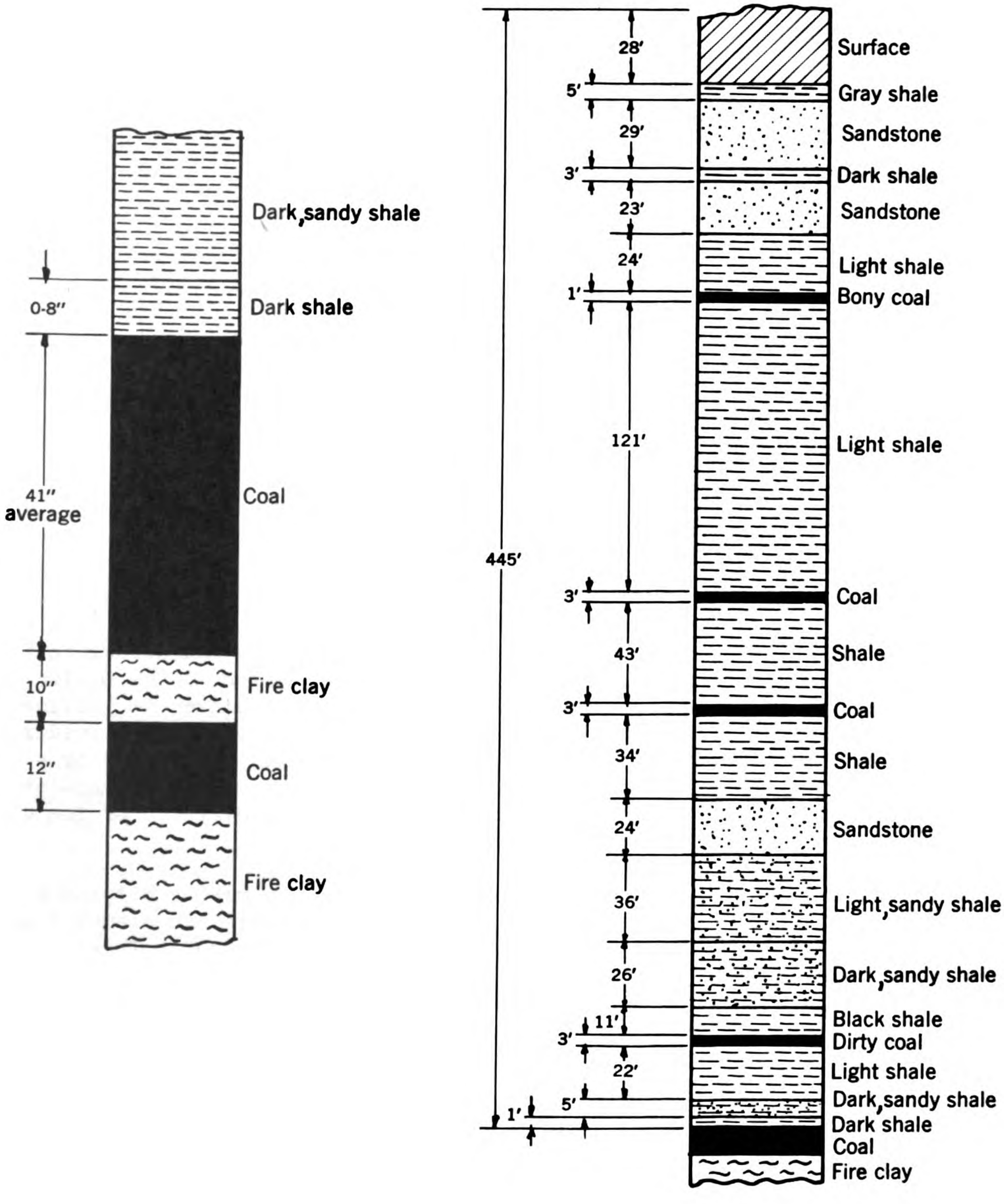

Figure 28. - Section of coal bed and overburden at mine 9.

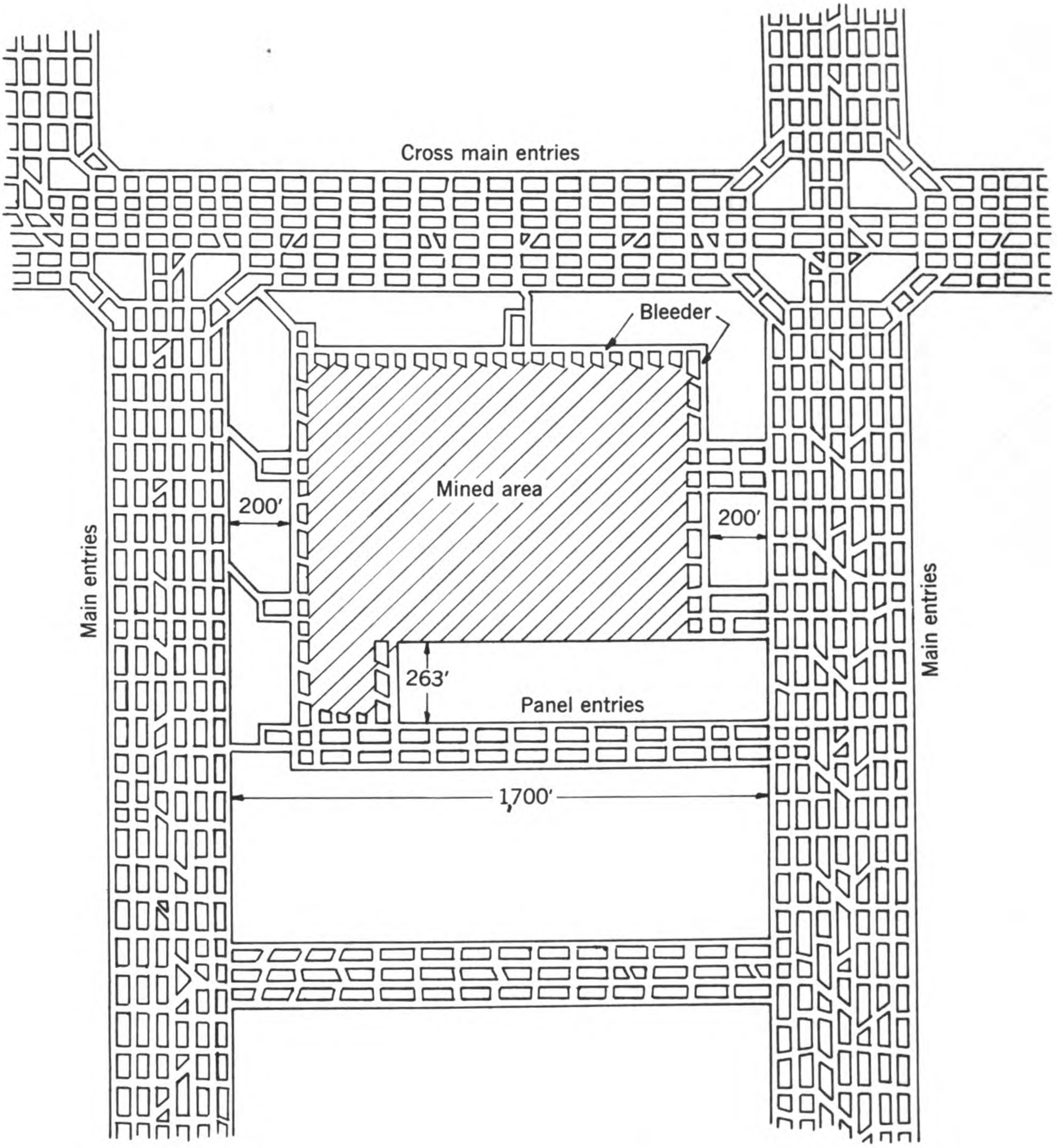

Figure 29. - Mining method at mine 9.

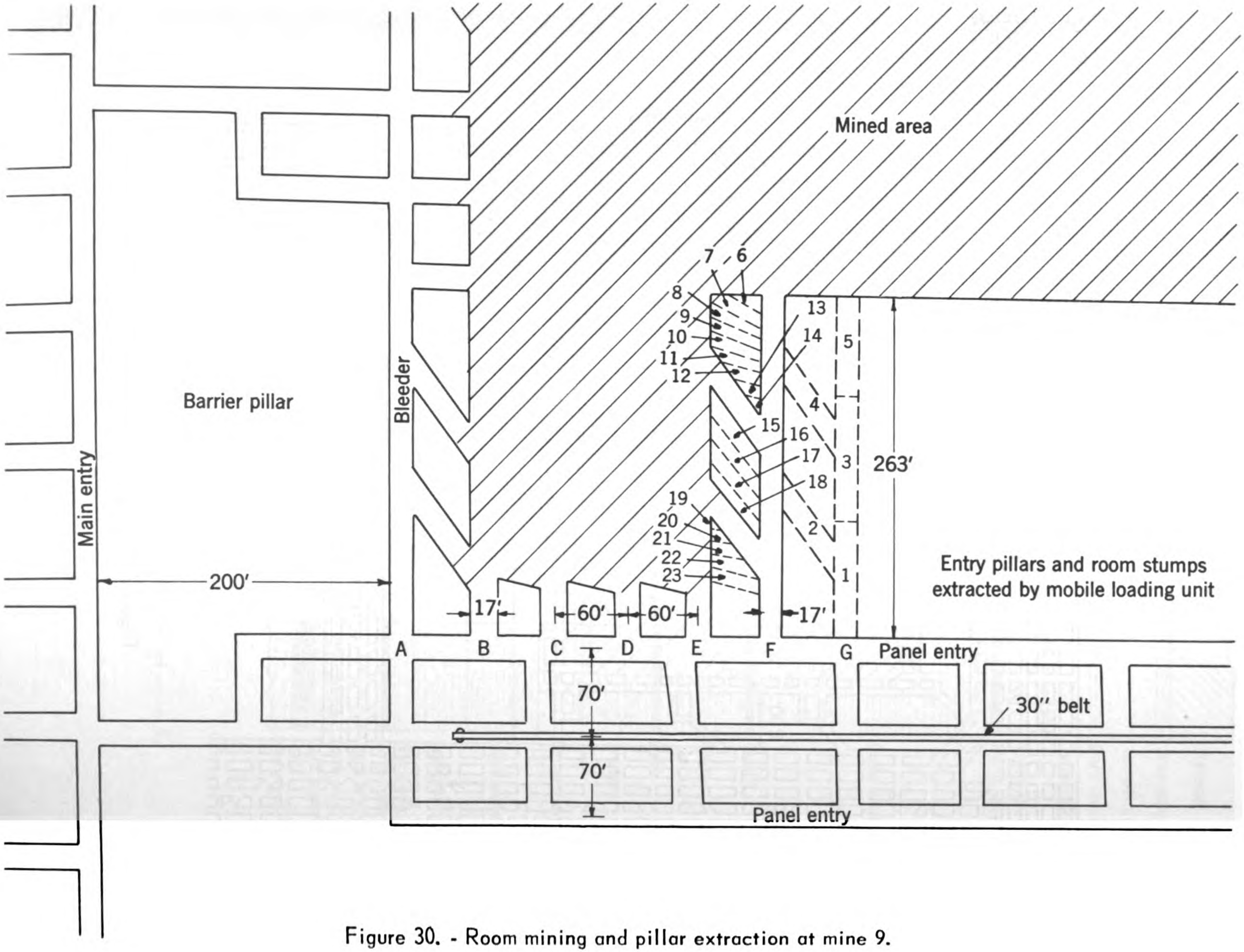

Figure 30. - Room mining and pillar extraction at mine 9.

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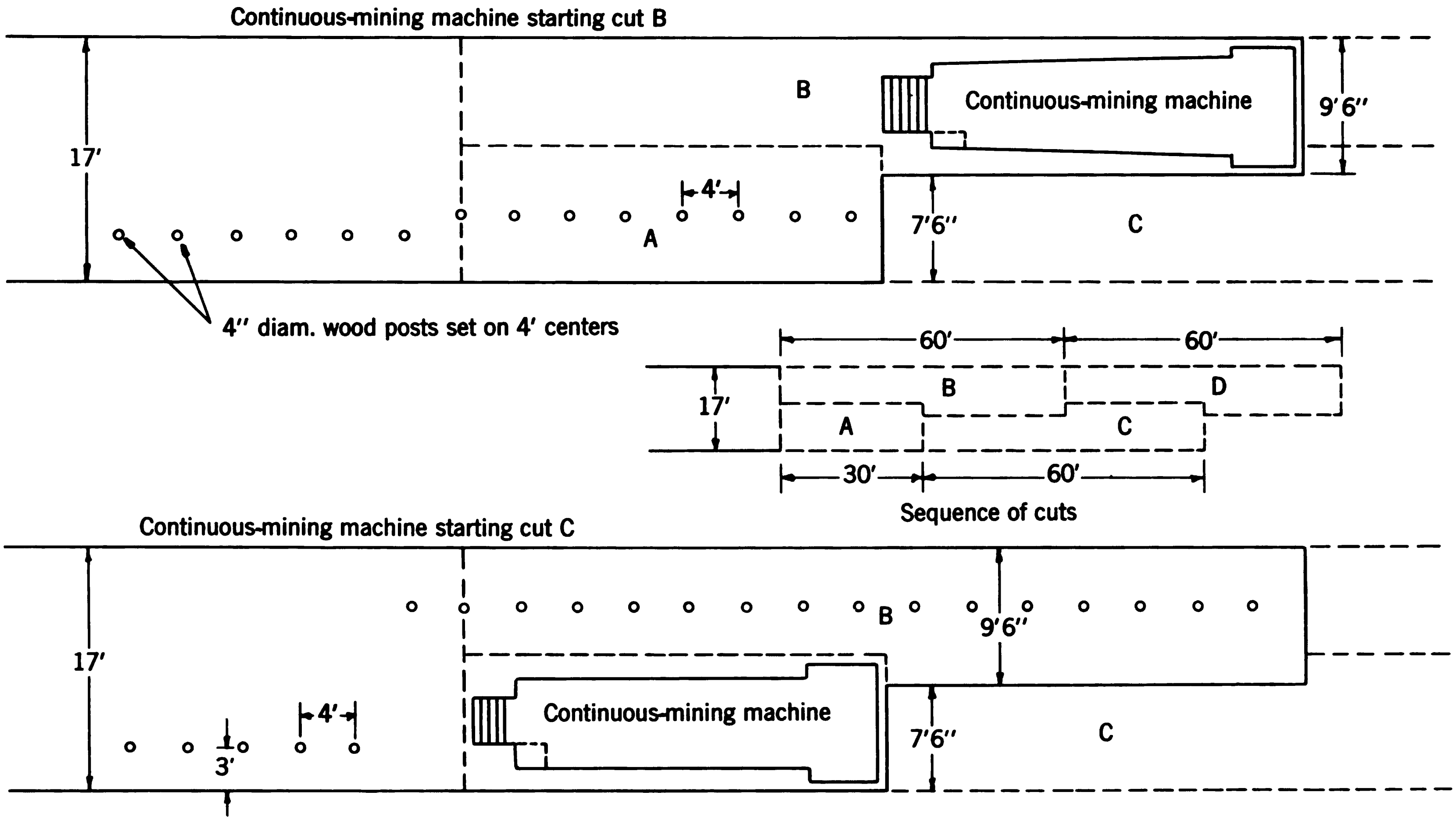

Continuous-mining machine starting cut B

17'
B
Continuous-mining machine
9'6"
4'
A
7'6"
C
4" diam. wood posts set on 4' centers

60'
60'
17'
B
D
A
C
30'
60'

Sequence of cuts

Continuous-mining machine starting cut C

17'
B
9'6"
4'
3'
Continuous-mining machine
7'6"
C

Figure 31. - Timbering plan and sequence of cuts in mining at mine 9.

Timberman (on pillar exgraction and room work only)	1
Boom man	1/2
Electrician-mechanic	1/2
Total	6-1/2

Travel time at this mine is 2 hours 15 minutes; no time lost for lunch (crew lunch period staggered); leaving 5 hours 45 minutes face time per shift. The average delay caused by mechanical failure is 40 minutes, 11.6 percent of face time. The average delay resulting from the continuous-mining machine waiting for shuttle cars is 1 hour 45 minutes, 30.4 percent of face time. Delays owing to changing bits, bringing supplies to the face, and maneuvering the continuous-mining machine amount to 45 minutes, 13 percent of face time. Actual productive time is 2 hours 35 minutes, 45 percent of face time. Temporary repairs necessary to keep the unit operating are done on shift by a mechanic. Major repairs and other maintenance work are done on the third shift by a mechanic and helper.

Classification of Employees

Classification	Shift[1]			Total
	1st	2d	3d	
Type B continuous-mining units:				
Section foremen	1	1	1	3
Continuous-mining-machine operators	2	2	2	6
Utility men	2	2	2	6
Shuttle-car operators	4	4	4	12
Timbermen	2	2	2	6
Boom men	1	1	1	3
Electrician-mechanics	1	1	1	3
Total employees, continuous-mining units	13	13	13	39
Total employees, hand-loading units	132	-	-	132
Total employees, mobile-loading units	75	75	75	225
Supervisory and inspection	19	3	2	24
Other underground employees	110	100	53	263
Total underground employees	349	191	143	683
Total surface employees	70	70	20	160
Total surface and underground employees	419	261	163	843

[1] 1st shift - 6:45 a.m. to 2:45 p.m.
2d shift - 2:00 p.m. to 10:00 p.m.
3d shift - 9:30 p.m. to 5:30 a.m.

Summary

	Continuous mining	Conventional mining	Hand loading
Percent of mine production	26.6	53.6	19.8
Hours per shift	8	8	8
Unit shifts per day	6	24	4
Average yield of clean coal, percent	91.5	91.5	91.5
Average advance of continuous-mining machine per shift, feet	100	-	-
Employees:			
In unit crews	39	225	132
Average daily production, raw coal, tons	1,079.4	2,175.1	803.5
Average production, raw coal per unit per shift, tons	179.9	90.6	200.9
Average production, raw coal per man per shift on unit, tons	27.7	9.7	6.1

Mine 10

Location..	Pennsylvania
Coal bed and thickness (fig. 32).................inches	Lower Kittanning - 48
Thickness of overburden (fig. 32).................feet	500
Production per day, raw coal......................tons	1,500
Total employees.......................................	193
Type A continuous-mining machines:	
Entry development.....................................	2
Room mining...	1
Mobile-loading units..................................	1
Shifts per day..	3
System of mining......................................	Room-and-pillar, pillars extracted
Estimated recovery of coal in place............percent	90
Mainline haulage......................................	Locomotive

Mining Method

Two type A continuous-mining machines, operated 6 unit shifts per day, are used to develop 1 set of 6 main entries and 1 set of 3 panel entries. Panel entries are turned 90° from the cross mains on 436-foot centers and are driven 16 feet wide on 60-foot centers for 2,600 feet. Crosscuts are turned on 60° from both sides of the middle entry and staggered on 84-foot centers. The sequence of cuts to advance three panel entries is shown by cuts 1 to 4. (See fig. 33.) After the panel has reached the 2,500-foot limit, rooms 16 feet wide on 56-foot centers are turned up the dip. One type A continuous-mining machine, operated three unit shifts per day, is used to mine rooms. The two inby rooms (A and B) are mined simultaneously by making cuts 1 to 6, inclusive, as shown in figure 34. The pillars between these rooms are extracted as shown by cuts 7 to 15 and room C is mined by making cuts 16, 17, and 18. Mining in the panel proceeds by repeating the cycle of cuts 7 to 18, inclusive. Panel-entry pillars are extracted by making cuts similar to those made in extracting the room pillars. A single row of wood props on 4-foot centers is set in rooms 4 feet from the rib and in pillar extraction, a single row of wood props is set along each rib. The average advance of the continuous-mining machine in entries and rooms 63.4 feet per shift.

A continuous-mining unit comprises 6 men, 1 continuous-mining machine, 2 cable-reel shuttle cars, and a 30-inch belt. One of the shuttle cars is used behind the continuous-mining machine as a surge car, and the other transports the coal from the surge car to the unloading station. The shuttle car is equipped with an elevating conveyor, which discharges the coal onto the 30-inch belt.

A continuous-mining crew consists of 6 men as follows:

Section foreman................................	1/2
Continuous-mining-machine operator.............	1
Shuttle-car operators..........................	2
Timberman......................................	1
Car trimmer....................................	1/2
Electrician-mechanic...........................	1
Total..	6

Travel time at this mine is 2 hours; no time lost for lunch; leaving 6 hours face time per shift. The average delay caused by mechanical failure is 1 hour, 16.7

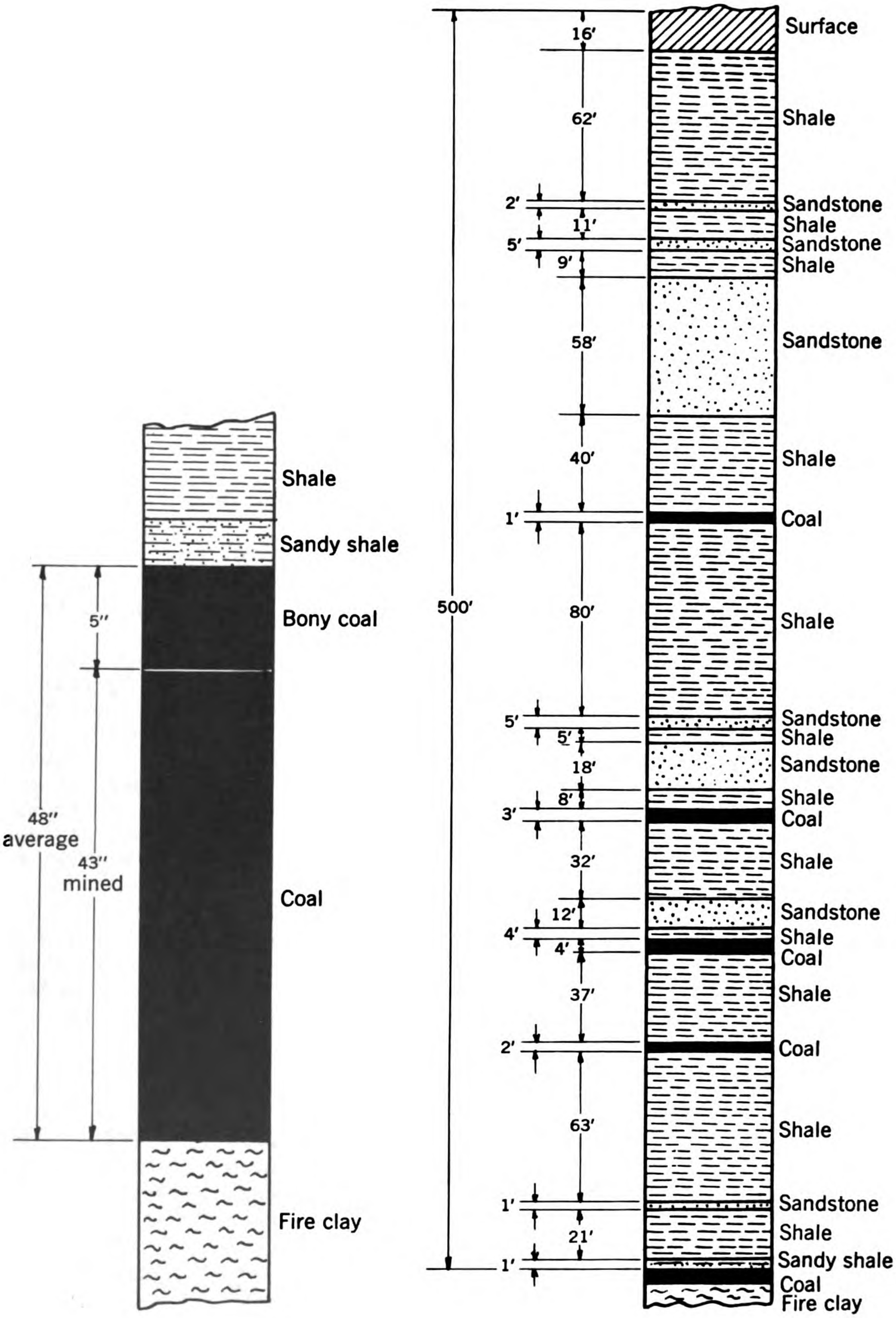

Figure 32. - Section of coal bed and overburden at mine 10.

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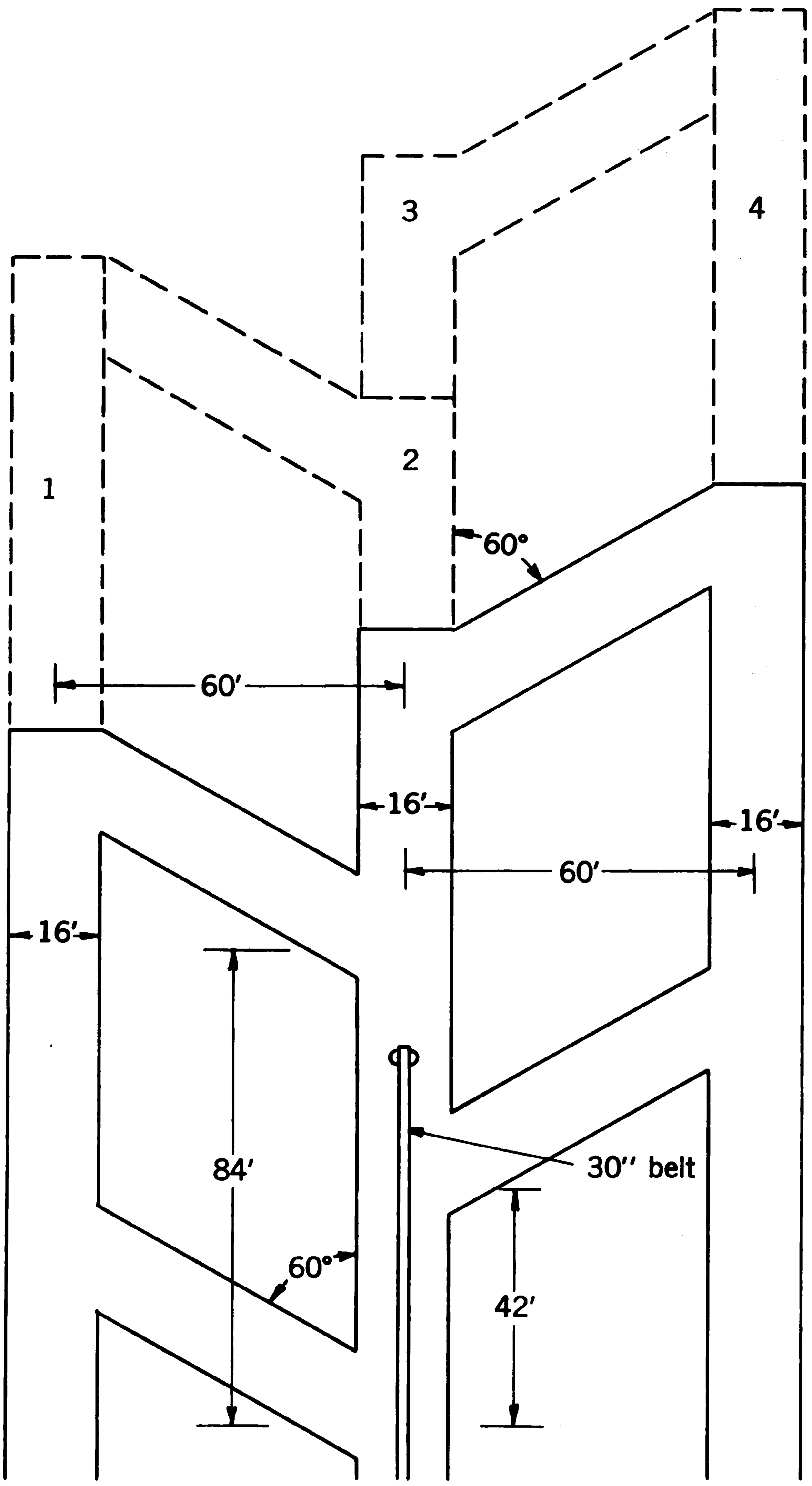

Figure 33. - Panel-entry development at mine 10.

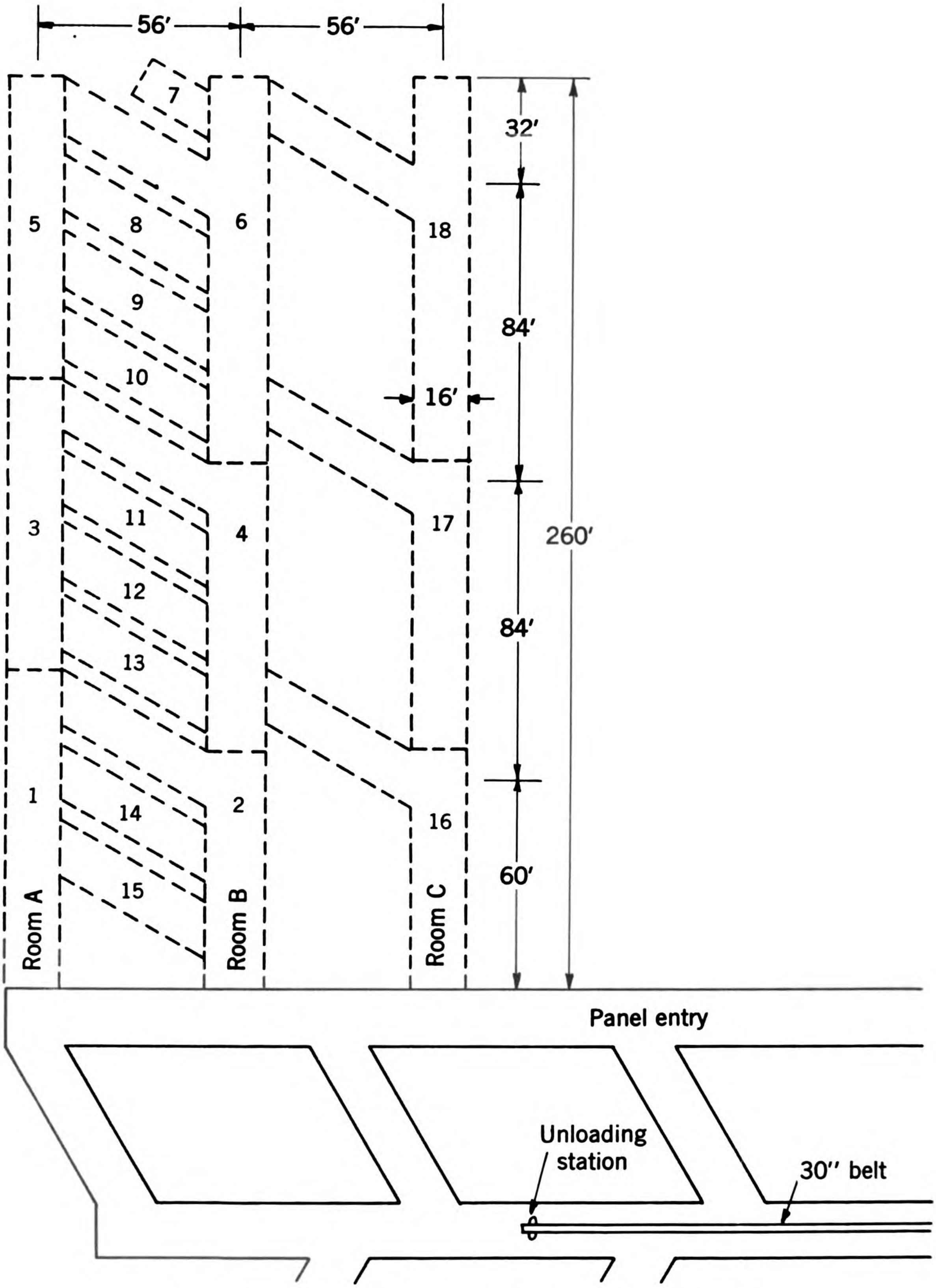

Figure 34. - Room mining and pillar extraction at mine 10.

percent of face time. Other delays as maneuvering the continuous-mining machine, timbering, power failure, bit change, greasing, and waiting for empty cars amount to 30 minutes, 8.3 percent of face time. Actual productive time is 4 hours 30 minutes, 75 percent of face time. All maintenance, moving, and other work necessary to keep the continuous-mining machine operating is done on the first 2 hours of the first shift by a mechanic and the crew.

Classification of Employees

Classification	Shift[1] 1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	1-1/2	1-1/2	1-1/2	4-1/2
Continuous-mining-machine operators	3	3	3	9
Shuttle-car operators	6	6	6	18
Timbermen	3	3	3	9
Car trimmers	1-1/2	1-1/2	1-1/2	4-1/2
Electrician-mechanics	3	3	3	9
Total employees, continuous-mining units	18	18	18	54
Total employees, mobile-loading units	11	11	11	33
Supervisory and inspection	5	-	-	5
Other underground employees	42	16	16	74
Total underground employees	76	45	45	166
Total surface employees	18	7	2	27
Total surface and underground employees	94	52	47	193

---

[1] 1st shift - 6:30 a.m. to 2:30 p.m.
2d shift - 3:30 p.m. to 11:30 p.m.
3d shift - 10:30 p.m. to 6:30 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	80		20	
Hours per shift	8		8	
Unit shifts per day	9		3	
Average yield of clean coal ... percent	87		87	
Average advance of continuous-mining machine per shift ... feet	63.4		-	
Employees:				
In unit crews		54		33
Supervisory and other underground		63		16
Surface		22		5
Total charged to	139		54	
Average daily production, raw coal ... tons	1,200		300	
Average production, raw coal per unit per shift ... tons	133.3		100	
Average production, raw coal per man per shift on unit ... tons	22.2		9.1	
Average production, raw coal per underground man shift ... tons	10.3		6.1	
Average production, raw coal per payroll man shift ... tons	8.6		5.6	

Mine 11

Location	Pennsylvania
Coal bed and thickness (fig. 35)..................inches	Lower Kittanning - 50 (42 inches mined)
Thickness of overburden (fig. 35)..................feet	526
Production per day, raw coal........................tons	5,235
Total employees..	721
Type A continuous-mining machines:	
Entry development....................................	4
Room mining and pillar extraction....................	2
Mobile-loading units......................................	17
Shifts per day..	3
System of mining..	Block, pillars extracted
Estimated recovery of coal in place.............percent	91
Mainline haulage..	Locomotive and 30- and 36-inch belts

Mining Method

Three type A continuous-mining machines, operated 9 unit shifts per day, are used to develop a 9-entry panel, and 1 type A continuous-mining machine, operated 3 unit shifts per day, is used to develop 3 panel entries. (See fig. 36.) Entries are driven 16 feet wide on 60-foot centers and crosscuts 16 feet wide on 80-foot centers, developing blocks of coal 64 feet long by 44 feet wide. One type A continuous-mining machine is used to develop a set of three entries. The sequence of cuts to advance the three center entries is shown by the broken lines, cuts 1-A to 8-A and cuts 1-D to 8-D in figure 36. The sequence of cuts to advance the entries on either side of the center entries is shown by the broken lines (cuts 1-B to 4-B and 1-C to 4-C). After the panel is developed to its predetermined limit (2,000 feet), one row of pillars is left for a bleeder entry, and then the other entry pillars are extracted on retreat. (See fig. 37.) Two type A continuous-mining machines (one on each side of the belt entry) operated 4 unit shifts per day, are used to extract the entry pillars and one-half of the 140-foot barrier pillars between the panels. The sequence of cuts to extract entry pillars and barrier pillars is shown by the broken lines, cuts 1 to 26. (See fig. 37.) The average advance of the continuous-mining machine in a 16-foot entry is 50.4 feet per shift. A single row of wood posts on 4-foot centers and set 3 feet from the rib is used in entries and crosscuts to support the roof.

A continuous-mining unit comprises 5-1/3 men, 1 type A continuous-mining machine, 2 cable-reel shuttle cars, and one 30-inch belt. One of the shuttle cars is used behind the continuous-mining machine as a surge car, and the other transports the coal from the surge car to the unloading station. The shuttle car is equipped with an elevating conveyor, which discharges the coal onto the 30-inch belt.

A continuous-mining crew consists of 5-1/3 men as follows:

Section foreman..................................	1/2
Continuous-mining-machine operator...............	1
Continuous-mining-machine helper.................	1
Shuttle-car operators............................	2
Belt trimmer.....................................	1/3
Electrician-mechanic.............................	1/2
Total..	5-1/3

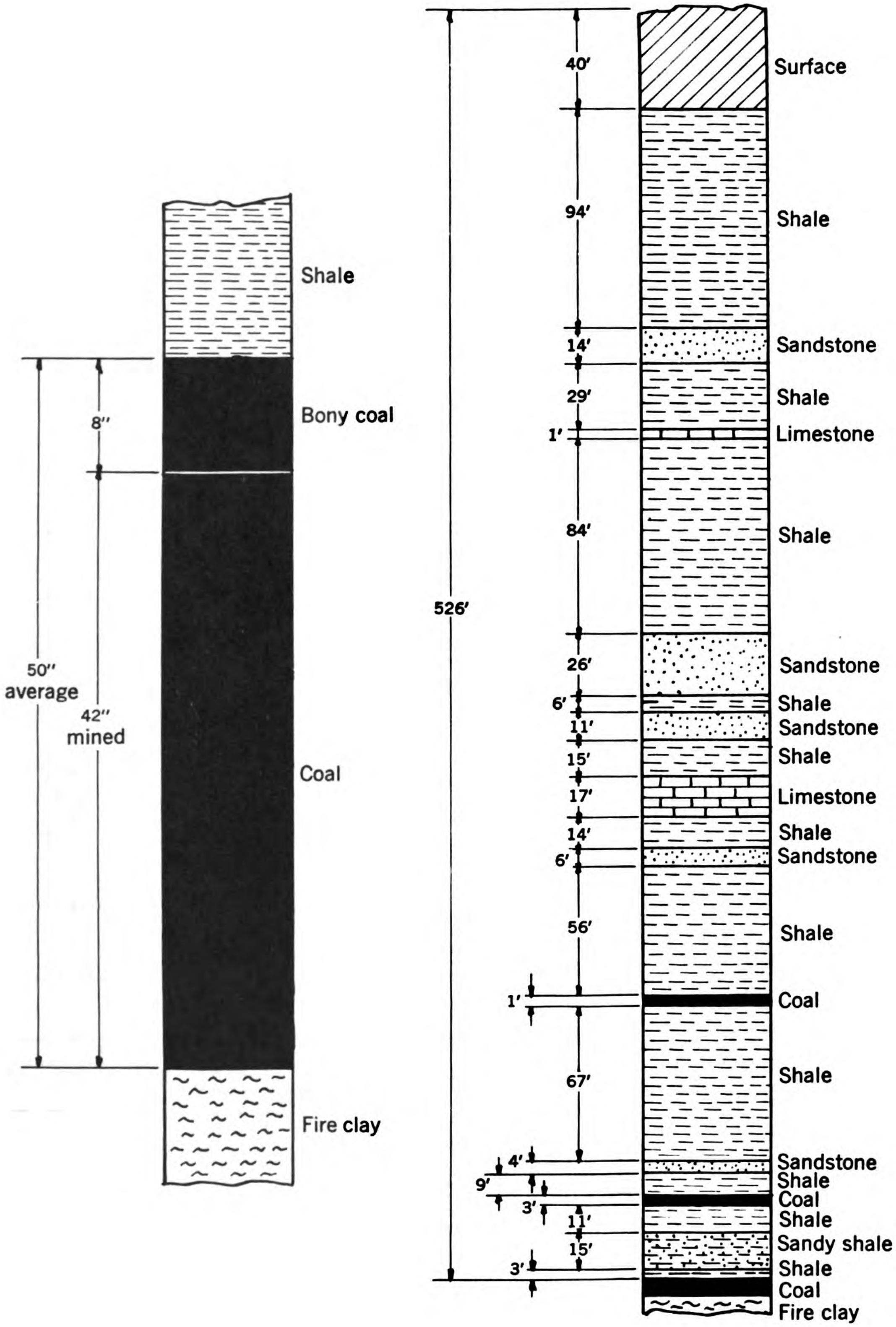

Figure 35. - Section of coal bed and overburden at mine 11.

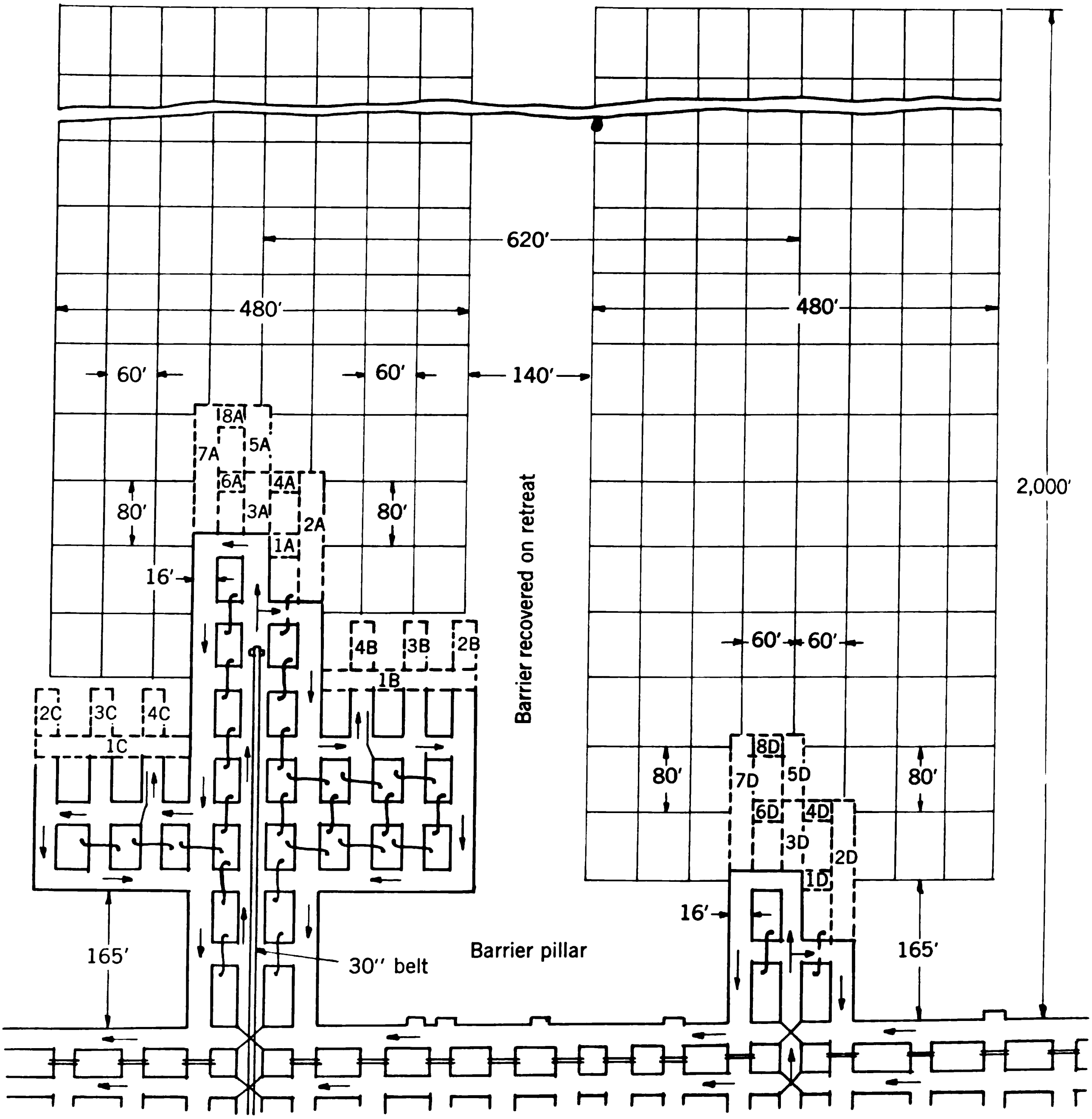

Figure 36. - Panel-entry development at mine 11.

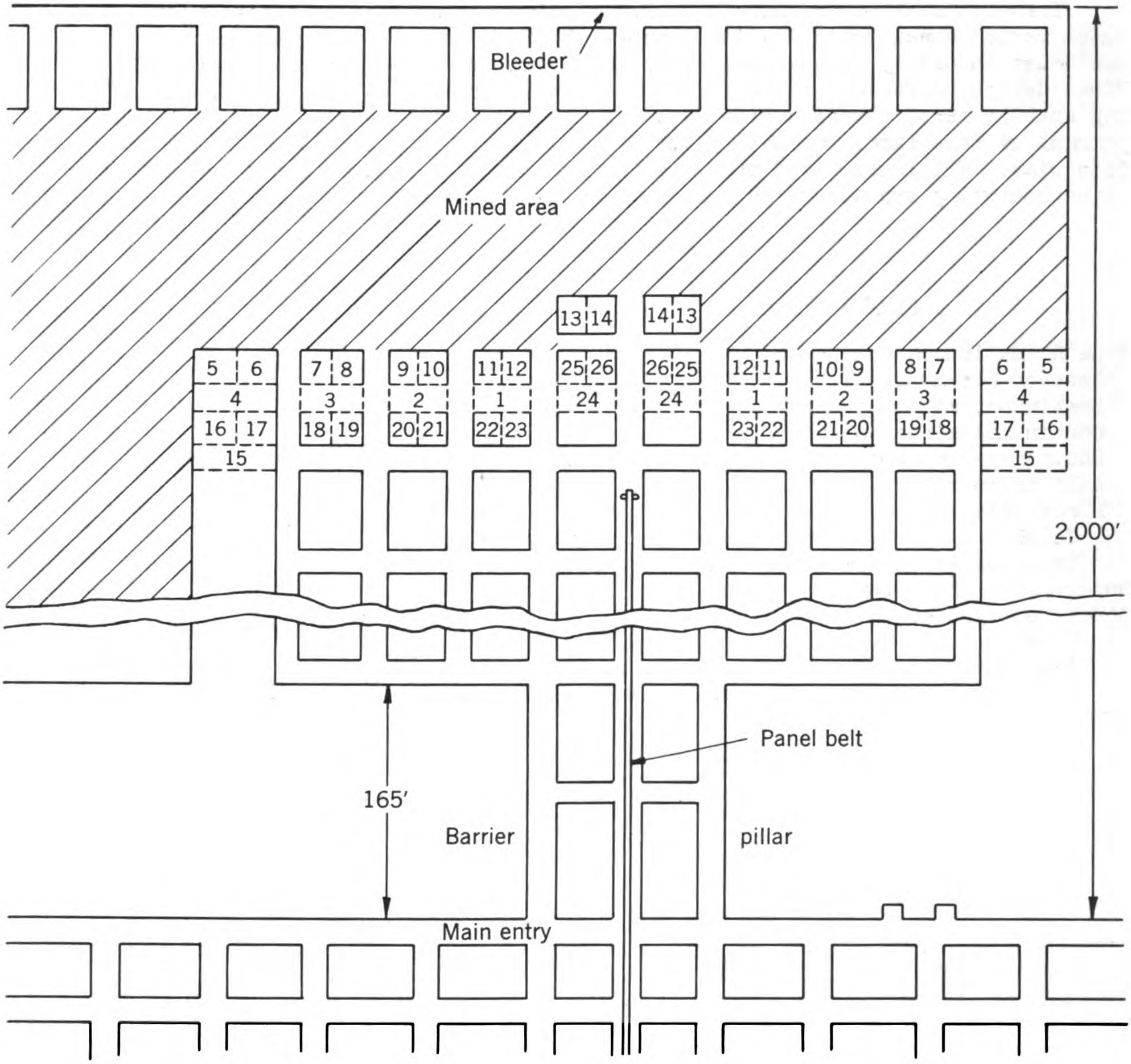

Figure 37. - Pillar extraction at mine 11.

Travel time at this mine is 1 hour 15 minutes; no time lost for lunch (crew lunch period staggered); leaving 6 hours 45 minutes face time per shift. The average delay caused by mechanical failure is 30 minutes, 7.4 percent of face time. Other delays, such as maneuvering the continuous-mining machine, timbering, repairing shuttle cars, changing bits, and handling supplies, etc., amount to 1 hour, 14.8 percent of face time. Actual productive time is 5 hours 15 minutes, 77.8 percent of face time. All repairs and other work necessary to keep the continuous-mining machine operating are done by a crew between the first and second shifts.

Classification of Employees

Classification	Shift[1/] 1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	3	3	2	8
Continuous-mining-machine operators	6	6	4	16
Continuous-mining-machine helpers	6	6	4	16
Shuttle-car operators	12	12	8	32
Belt trimmers	2	2	1	5
Electrician-mechanics	3	3	2	8
Total employees, continuous-mining units	32	32	21	85
Total employees, mobile-loading units	135	115	48	298
Supervisory and inspection	15	14	8	37
Other underground employees	142	55	33	230
Total underground employees	324	216	110	650
Total surface employees	30	30	11	71
Total surface and underground employees	354	246	121	721

1/ 1st shift - 6:20 a.m. to 2:20 p.m.
2d shift - 3:20 p.m. to 11:20 p.m.
3d shift - 11:00 p.m. to 7:00 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	37		63	
Hours per shift	8		8	
Unit shifts per day	16		37	
Average yield of clean coal ... percent	96		96	
Average advance of continuous-mining machine per shift ... feet	50.4		-	
Employees:				
In unit crews		85		298
Supervisory and other underground		99		168
Surface		26		45
Total charged to	210		511	
Average daily production, raw coal ... tons	1,937		3,298	
Average production, raw coal per unit per shift ... tons	121		89	
Average production, raw coal per man per shift on unit ... tons	22.8		11.1	
Average production, raw coal per underground man shift, ... tons	10.5		7.1	
Average production, raw coal per payroll man shift ... tons	9.2		6.5	

Mine 12

Location	Pennsylvania
Coal bed and thickness (fig. 38)...inches	Upper Kittanning - 69 (55 inches mined)
Thickness of overburden (fig. 38)...feet	270
Production per day, raw coal...tons	1,600
Total employees	175
Type A continuous-mining machine:	
Entry development	1
Mobile-loading units	3
Shifts per day	3
System of mining (fig. 39)	Room-and-pillar, pillars extracted
Estimated recovery of coal in place...percent	90
Mainline haulage	Locomotive

Mining Method

One type A continuous-mining machine, operated two unit shifts per day, is used to develop a set of five entries as shown by cuts 1 to 8 in figure 40. Entries are driven 105 feet, then crosscuts are begun at about an 80° angle and turned gradually to 90° to the entries. This is done to facilitate alignment of the surge car and shuttle car behind the continuous-mining machine. The sequence of cuts was devised to keep the tramming distance to a minimum and, although clay veins may interrupt it temporarily, the general method is followed. The average rate of advance of the continuous-mining machine is 60 feet per shift.

At the time of this study, development of the cross entry was in the initial stage, with the belt conveyor installed in entry 4 and discharging into mine cars in the main heading. When development has progressed and the belt has been extended to 800 feet, track will be laid to serve the future loading station, as indicated by broken line. (See fig. 40.) The belt then will be moved as needed inby the future loading station in entry 3.

Supplies are carried to the face in the shuttle car. Where timbering is required on development, 6- by 8-inch by 14-foot crossbars are set on wood posts by the crew.

A continuous-mining unit comprises 6-1/2 men, 1 continuous-mining machine, 2 cable-reel shuttle cars, and one 30-inch belt. The machine is crawler-mounted and moves along the center of the entry cutting a 14-foot face. One shuttle car, which has one-half of the flights removed from the conveyor, serves behind the continuous-mining machine, providing a surge capacity of 3-1/2 tons. The other shuttle car transports the coal from the surge car and discharges the coal from a wood ramp to a 30-inch belt conveyor. Three-ton-capacity, steel mine cars are loaded directly from the belt at the loading station. A car hoist is used to spot the mine cars.

A continuous-mining crew consists of 6-1/2 men as follows:

Section foreman	1
Continuous-mining-machine operator	1
Shuttle-car operators	2
Boom man	1
Electrician-mechanic	1-1/2
Total	6-1/2

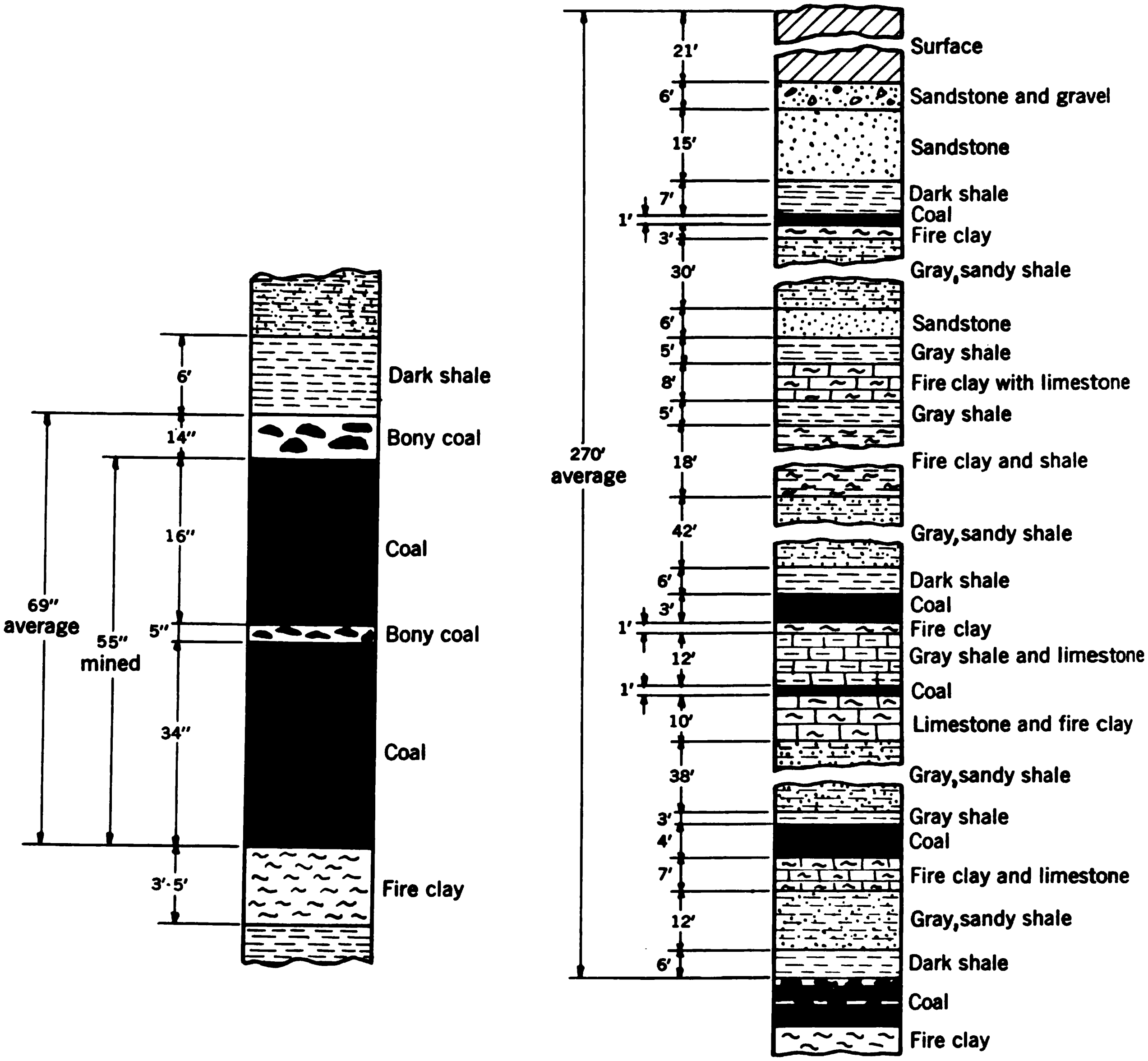

Figure 38. - Section of coal bed and overburden at mine 12.

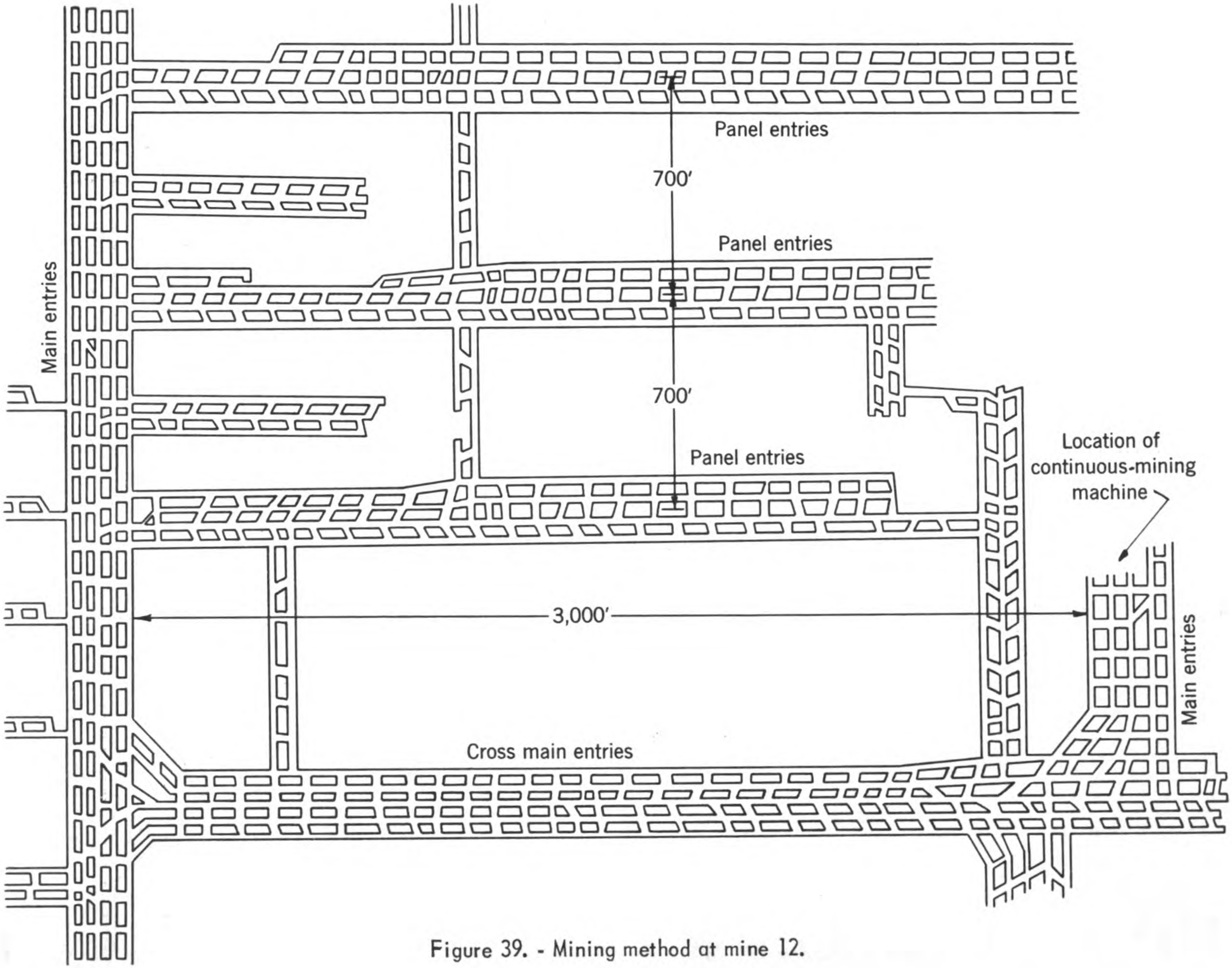

Figure 39. - Mining method at mine 12.

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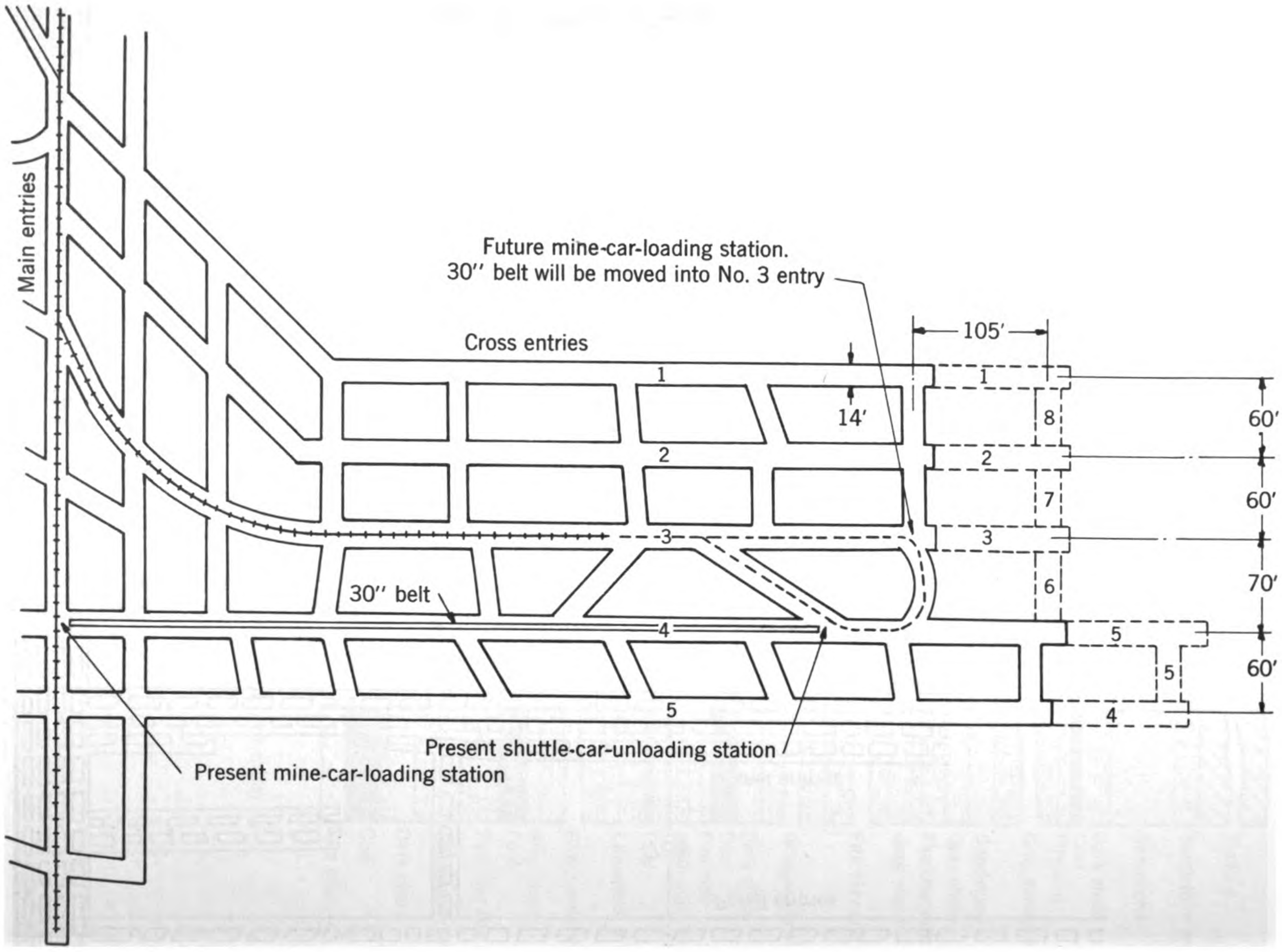
Main entries
Future mine-car-loading station.
30'' belt will be moved into No. 3 entry
Cross entries
105'
1
14'
2
3
30'' belt
4
5
1
8
2
7
3
6
5
5
4
60'
60'
70'
60'
Present shuttle-car-unloading station
Present mine-car-loading station

Figure 40. - Main-entry development at mine 12.

Travel time at this mine is 1 hour; lunch time, 30 minutes; leaving 6 hours 30 minutes face time per shift. The average delay caused by mechanical failure is 52 minutes, 13.3 percent of face time. Other delays, such as maneuvering the continuous-mining machine, timbering, power failure, bit change, greasing, and waiting for empty cars amount to 34 minutes, 8.7 percent of face time. Actual productive time is 5 hours 4 minutes, 78 percent of face time. All maintenance and other work necessary to keep the continuous-mining machine operating is done between the first and second shifts (2:30 p.m. to 6:30 p.m.) by a mechanic.

Classification of Employees

Classification	Shift 1/			
	1st	2d	3d	Total
Type A continuous-mining unit:				
Section foremen	1	1	-	2
Continuous-mining machine operators	1	1	-	2
Shuttle-car operators	2	2	-	4
Boom men	1	1	-	2
Electrician-mechanics	1-1/2	1-1/2	-	3
Total employees, continuous-mining unit	6-1/2	6-1/2	-	13
Total employees, mobile-loading units	30	30	20	80
Supervisory and inspection	2	1	1	4
Other underground employees	24	8	18	50
Total underground employees	62-1/2	45-1/2	39	147
Total surface employees	18	10	-	28
Total surface and underground employees	80-1/2	55-1/2	39	175

1/ Type A continuous-mining unit:
1st shift - 6:30 a.m. to 2:30 p.m.
2d shift - 6:30 p.m. to 2:30 a.m.
Mobile-loading units:
1st shift - 6:30 a.m. to 2:30 p.m.
2d shift - 2:30 p.m. to 10:30 p.m.
3d shift - 10:00 p.m. to 6:00 a.m.

Summary

	Continuous mining	Conventional mining
Percent of mine production	22.5	77.5
Hours per shift	8	8
Unit shifts per day	2	8
Average yield of clean coal ... percent	90	90
Average advance of continuous-mining machine per shift ... feet	60	-
Employees:		
In unit crews	13	80
Supervisory and other underground	12	42
Surface	6	22
Total charged to	31	144
Average daily production, raw coal ... tons	360	1,240
Average production, raw coal per unit per shift ... tons	180	155
Average production, raw coal per man per shift on unit ... tons	27.7	15.5
Average production, raw coal per underground man shift ... tons	14.4	10.2
Average production, raw coal per payroll man shift ... tons	11.6	8.6

Mine 13

Location	Pennsylvania
Coal bed and thickness (fig. 41)..........inches	Thick Freeport - 74
Thickness of overburden (fig. 41)..........feet	450
Production per day, raw coal..........tons	2,828
Total employees	287
Type A continuous-mining machines:	
Pillar extraction	5
Mobile-loading units	2
Shifts per day	3
System of mining	Retreat, pillars extracted
Estimated recovery of coal in place..........percent	85
Mainline haulage	Locomotive

Mining Method

Two mobile-loading units, operated four unit shifts per day, are used to clean up old entries preparatory to pillar mining. Five type A continuous-mining machines, operated 15 unit shifts per day, are used to extract entry chain and barrier pillars.

Barrier pillars are developed into blocks 85 feet square by room entries and crosscuts driven 15 feet wide on 100-foot centers. These blocks are mined by driving 15-foot rooms to the mined area, leaving a 10-foot rib that is mined on retreat. The sequence of cuts for room development and rib extraction is shown by cuts 1 to 5 in figure 42. Small stumps are left to support the roof until the rib is mined. The main stump is drilled and blasted to begin a fall, which rides over and crushes the other stumps. Usually, a good fall is obtained while the next room is being driven. When blocks A and B are mined, the same method of mining is used to recover blocks in the barrier pillar on the opposite side of the entries.

The method of chain pillar recovery is governed by the size and shape of the pillar and by the amount of roof rock clean-up required to make it available for mining. The details of the method of chain pillar recovery are left to the judgment of the section foreman. Usually, a 15-foot crosscut is driven to divide the pillar into 2 sections; then a 15-foot split is driven through each section. If possible, the remaining parts of the pillars are mined on retreat, leaving small stumps to support the roof. These stumps are crushed by the caving of the roof.

Five- by 7-inch by 14-foot wood crossbars are set on wood posts at a maximum distance of 6 feet apart or closer, if necessary. Timbering is not required in the rib cuts because the machine operator is protected by the room timbering. Crossbars and posts are not recovered.

Air is conducted over the machine by line brattice, then through the mined area to the return airway. Air-tight plastic curtains are used with the ordinary brattice cloth in temporary stoppings to reduce air leakage and improve face ventilation.

A continuous-mining unit comprises 7 men, 1 continuous-mining machine, 1 mobile-loading machine, and 1 cable-reel shuttle car. The continuous-mining machine is crawler mounted and moves along the center line cutting a 15-foot face. The mining machine discharges coal onto the floor, which provides an adequate surge capacity. This permits the operator to continue to operate the continuous-mining machine without regard for alignment of the boom to load the shuttle car. The mobile-loading

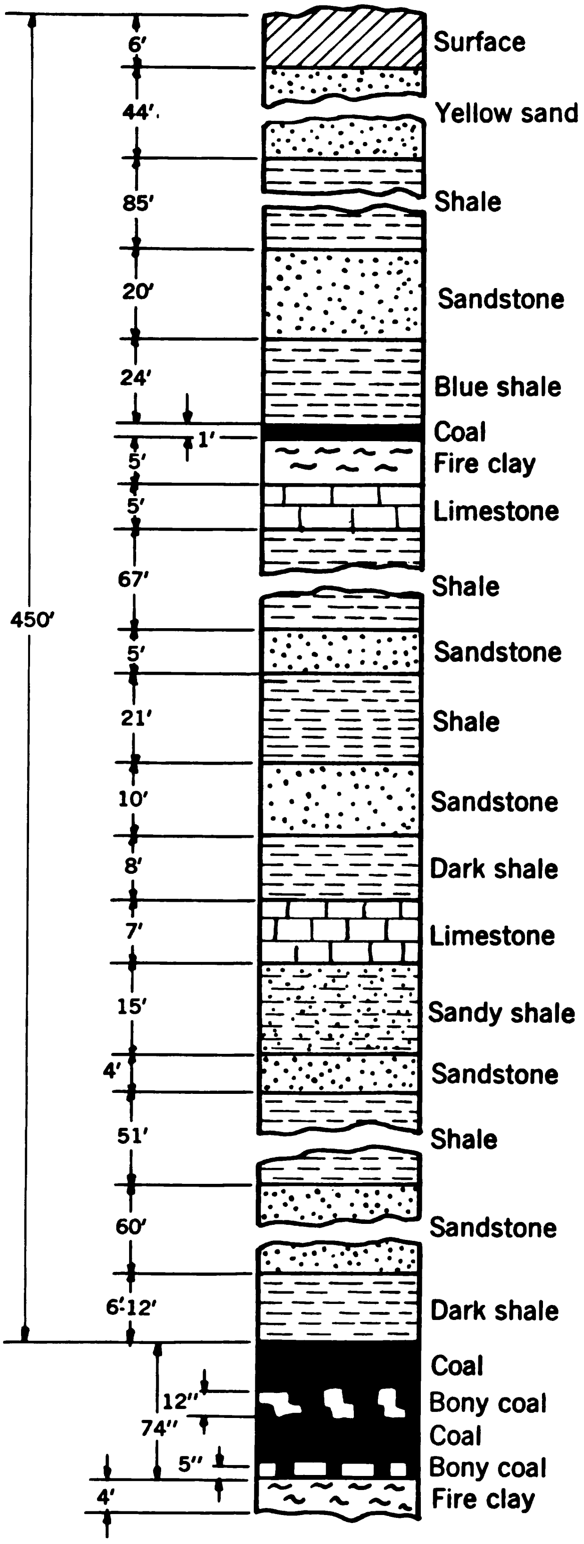

Figure 41. - Section of coal bed and overburden at mine 13.

Mine 13

Location..	Pennsylvania
Coal bed and thickness (fig. 41)...................inches	Thick Freeport - 74
Thickness of overburden (fig. 41)....................feet	450
Production per day, raw coal.........................tons	2,828
Total employees...	287
Type A continuous-mining machines:	
Pillar extraction......................................	5
Mobile-loading units....................................	2
Shifts per day..	3
System of mining..	Retreat, pillars extracted
Estimated recovery of coal in place..............percent	85
Mainline haulage..	Locomotive

Mining Method

Two mobile-loading units, operated four unit shifts per day, are used to clean up old entries preparatory to pillar mining. Five type A continuous-mining machines, operated 15 unit shifts per day, are used to extract entry chain and barrier pillars.

Barrier pillars are developed into blocks 85 feet square by room entries and crosscuts driven 15 feet wide on 100-foot centers. These blocks are mined by driving 15-foot rooms to the mined area, leaving a 10-foot rib that is mined on retreat. The sequence of cuts for room development and rib extraction is shown by cuts 1 to 5 in figure 42. Small stumps are left to support the roof until the rib is mined. The main stump is drilled and blasted to begin a fall, which rides over and crushes the other stumps. Usually, a good fall is obtained while the next room is being driven. When blocks A and B are mined, the same method of mining is used to recover blocks in the barrier pillar on the opposite side of the entries.

The method of chain pillar recovery is governed by the size and shape of the pillar and by the amount of roof rock clean-up required to make it available for mining. The details of the method of chain pillar recovery are left to the judgment of the section foreman. Usually, a 15-foot crosscut is driven to divide the pillar into 2 sections; then a 15-foot split is driven through each section. If possible, the remaining parts of the pillars are mined on retreat, leaving small stumps to support the roof. These stumps are crushed by the caving of the roof.

Five- by 7-inch by 14-foot wood crossbars are set on wood posts at a maximum distance of 6 feet apart or closer, if necessary. Timbering is not required in the rib cuts because the machine operator is protected by the room timbering. Crossbars and posts are not recovered.

Air is conducted over the machine by line brattice, then through the mined area to the return airway. Air-tight plastic curtains are used with the ordinary brattice cloth in temporary stoppings to reduce air leakage and improve face ventilation.

A continuous-mining unit comprises 7 men, 1 continuous-mining machine, 1 mobile-loading machine, and 1 cable-reel shuttle car. The continuous-mining machine is crawler mounted and moves along the center line cutting a 15-foot face. The mining machine discharges coal onto the floor, which provides an adequate surge capacity. This permits the operator to continue to operate the continuous-mining machine without regard for alignment of the boom to load the shuttle car. The mobile-loading

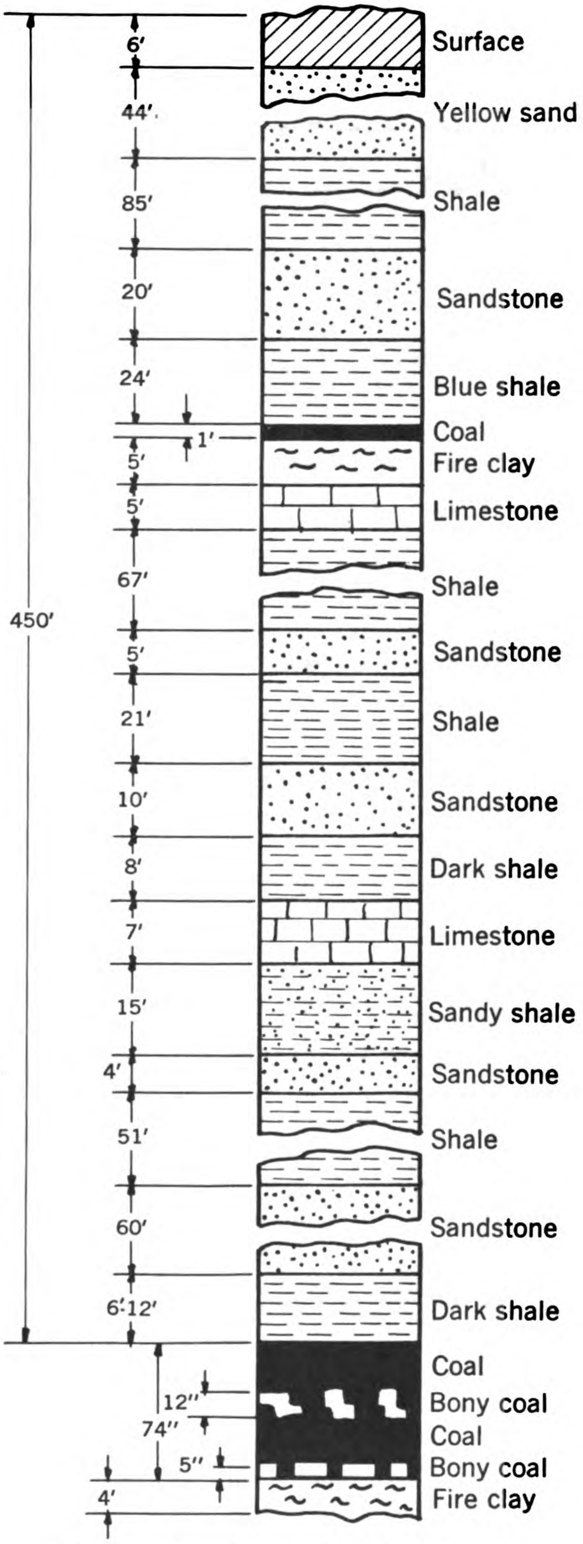

Figure 41. - Section of coal bed and overburden at mine 13.

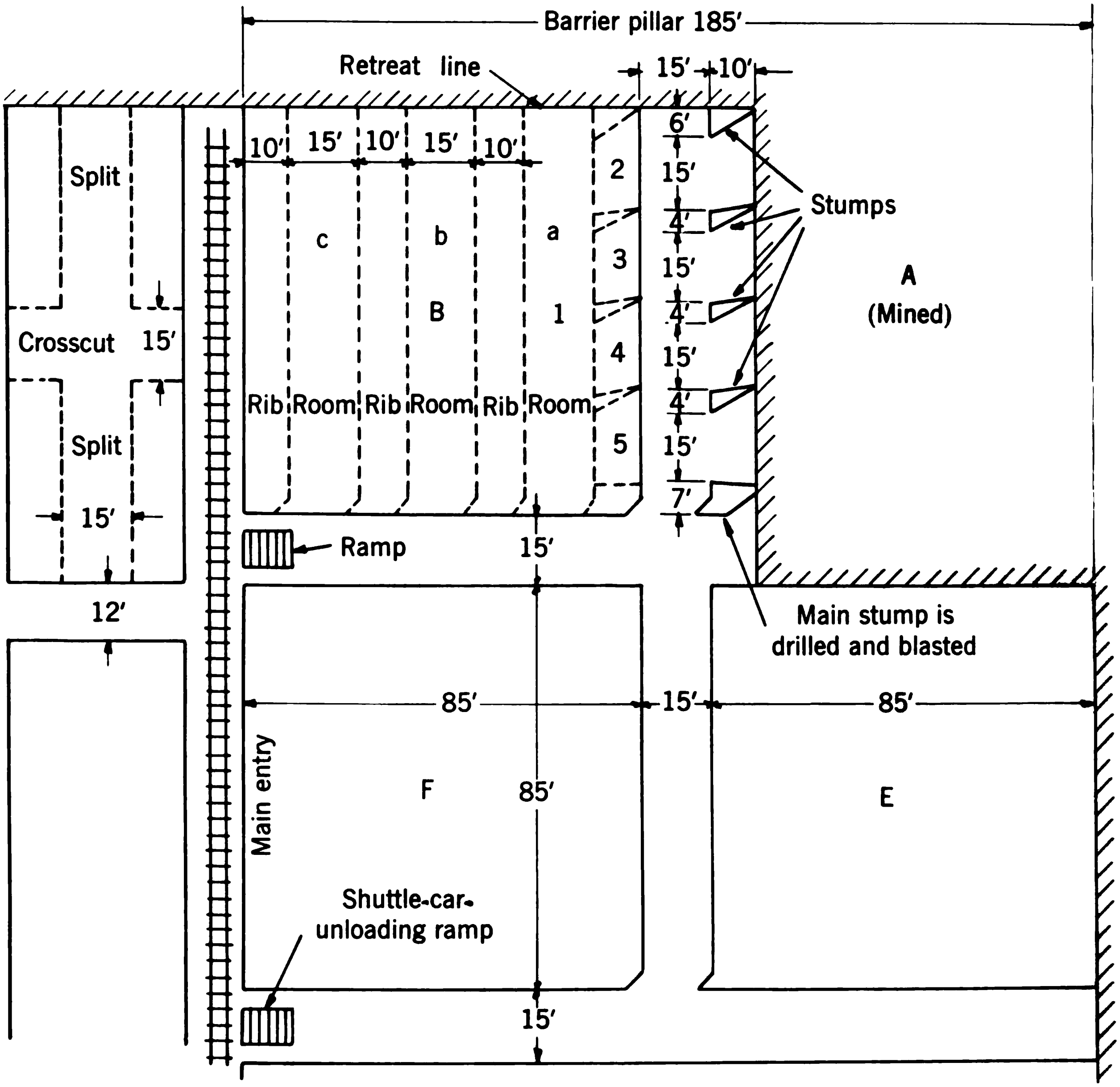

Figure 42. - Extraction of barrier pillar at mine 13.

machine reloads the coal into a 7-ton-capacity shuttle car. Use of the loading machine provides better clean-up and permits the shuttle car to be loaded to full capacity, which eliminates minor haulage delays. The shuttle car loads directly into 4-1/2-ton, steel mine cars, which are spotted by a robot locomotive that is remotely controlled by the shuttle-car operator.

Rock dusting is done on shift at lunch time with a small portable rock-dusting machine.

A continuous-mining crew consists of 7 men as follows:

Section foreman	1
Continuous-mining machine operator	1
Loading-machine operator	1
Shuttle-car operator	1
Timbermen	2
Electrician-mechanic	1
Total	7

Travel time at this mine is 1 hour 30 minutes; lunch time, 30 minutes, leaving 6 hours face time per shift. The average delay caused by mechanical failure is 24 minutes, 6.6 percent of face time. Other delays amount to 1 hour 56 minutes, 32.2 percent of face time. Total productive time is 3 hours 40 minutes, 61.2 percent of face time. All repairs, maintenance, moving, and other work necessary to keep the units operating are done on shift and between shifts, when necessary, by a mechanic.

Classification of Employees

Classification	Shift[1/]			Total
	1st	2d	3d	
Type A continuous-mining units:				
Section foremen	5	5	5	15
Continuous-mining-machine operators	5	5	5	15
Loading-machine operators	5	5	5	15
Shuttle-car operators	5	5	5	15
Timbermen	10	10	10	30
Electrician-mechanics	5	5	5	15
Total employees, continuous-mining units	35	35	35	105
Supervisory and inspection	14	2	2	18
Other underground employees	65	30	22	117
Total underground employees	114	67	59	240
Total surface employees	33	14	-	47
Total surface and underground employees	147	81	59	287

[1/] 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 3:00 p.m. to 11:00 p.m.
3d shift - 11:00 p.m. to 7:00 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	100		-	
Hours per shift	8		-	
Unit shifts per day	15		4	
Average yield of clean coal percent	99		-	
Average advance of continuous-mining machine per shift feet	50		-	
Employees:				
In unit crews		105		-
Supervisory and underground		135		-
Surface		47		
Total charged to	287		-	
Average daily production, raw coal tons	2,828		-	
Average production, raw coal per unit per shift tons	188.5		-	
Average production, raw coal per man per shift on unit tons	26.9		-	
Average production, raw coal per underground man shift tons	11.8		-	
Average production, raw coal per payroll man shift tons	9.8		-	

Mine 14

Location	Pennsylvania
Coal bed and thickness (fig. 43) inches	Pittsburgh - 78 (90 inches mined, including drawslate)
Thickness of overburden (fig. 43) feet	485
Production per day, raw coal tons	5,883
Total employees	644
Type A continuous-mining machines:	
Entry development	2
Mobile-loading units	10
Shifts per day	3
System of mining (fig. 44)	Block, pillars extracted
Estimated recovery of coal in place percent	85
Mainline haulage	Locomotive

Mining Method

Two type A continuous-mining machines, operated six unit shifts per day, are used to develop separate sets of butt entries. The butts usually are driven in sets of 5 on 100-foot centers, developing blocks of coal 85 feet square. A bleeder entry is maintained in the last completed butt panel for ventilation. (See fig. 44.)

The plan for the development of a butt-entry panel is shown in figure 45. The solid lines in entries 1 to 5, inclusive, show the advance of the entry faces at the end of a complete mining cycle. The broken lines show the advance of the entry faces at the end of the next complete mining cycle after cuts 1 to 18, inclusive,

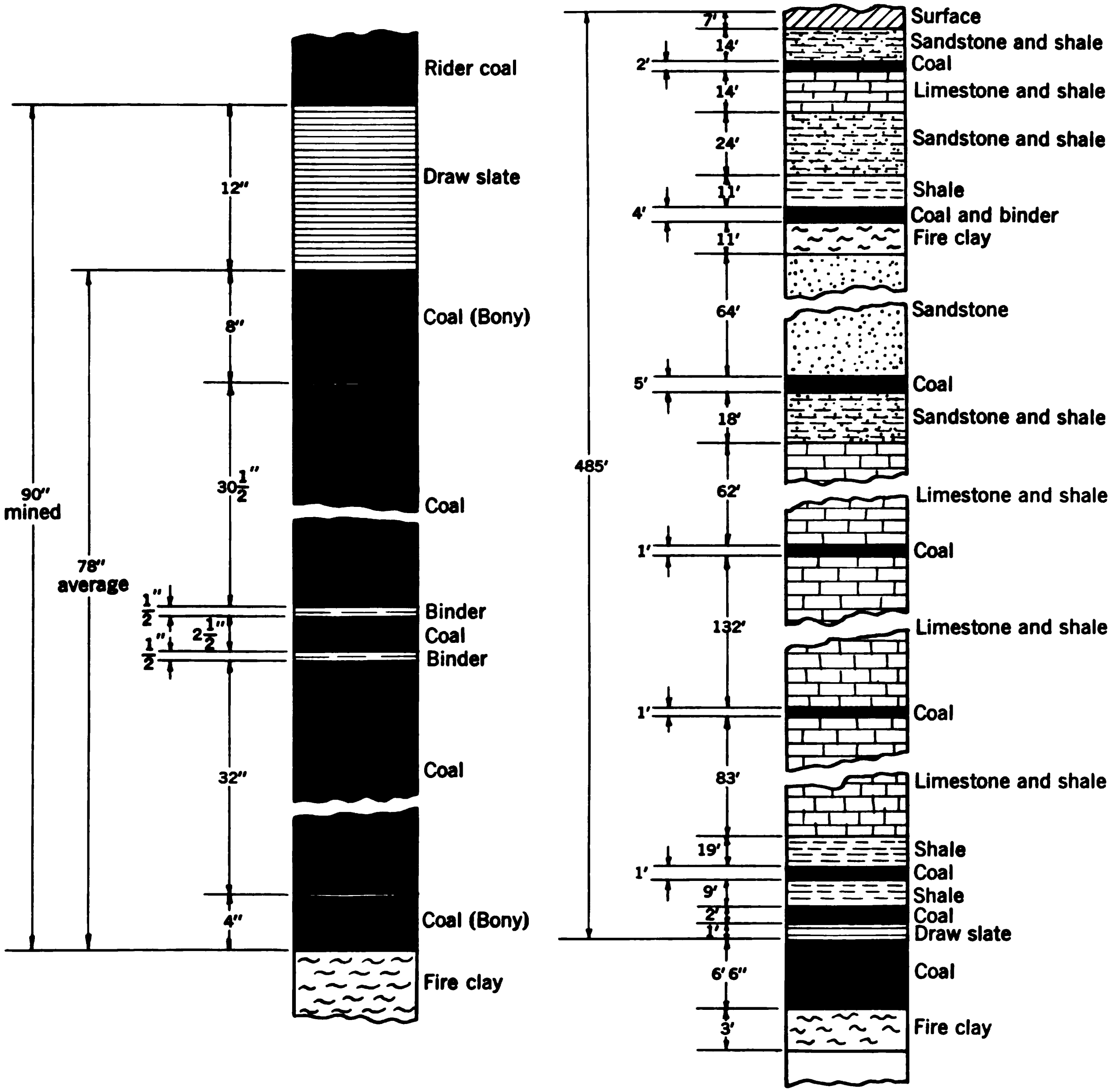

Figure 43. - Section of coal bed and overburden at mine 14.

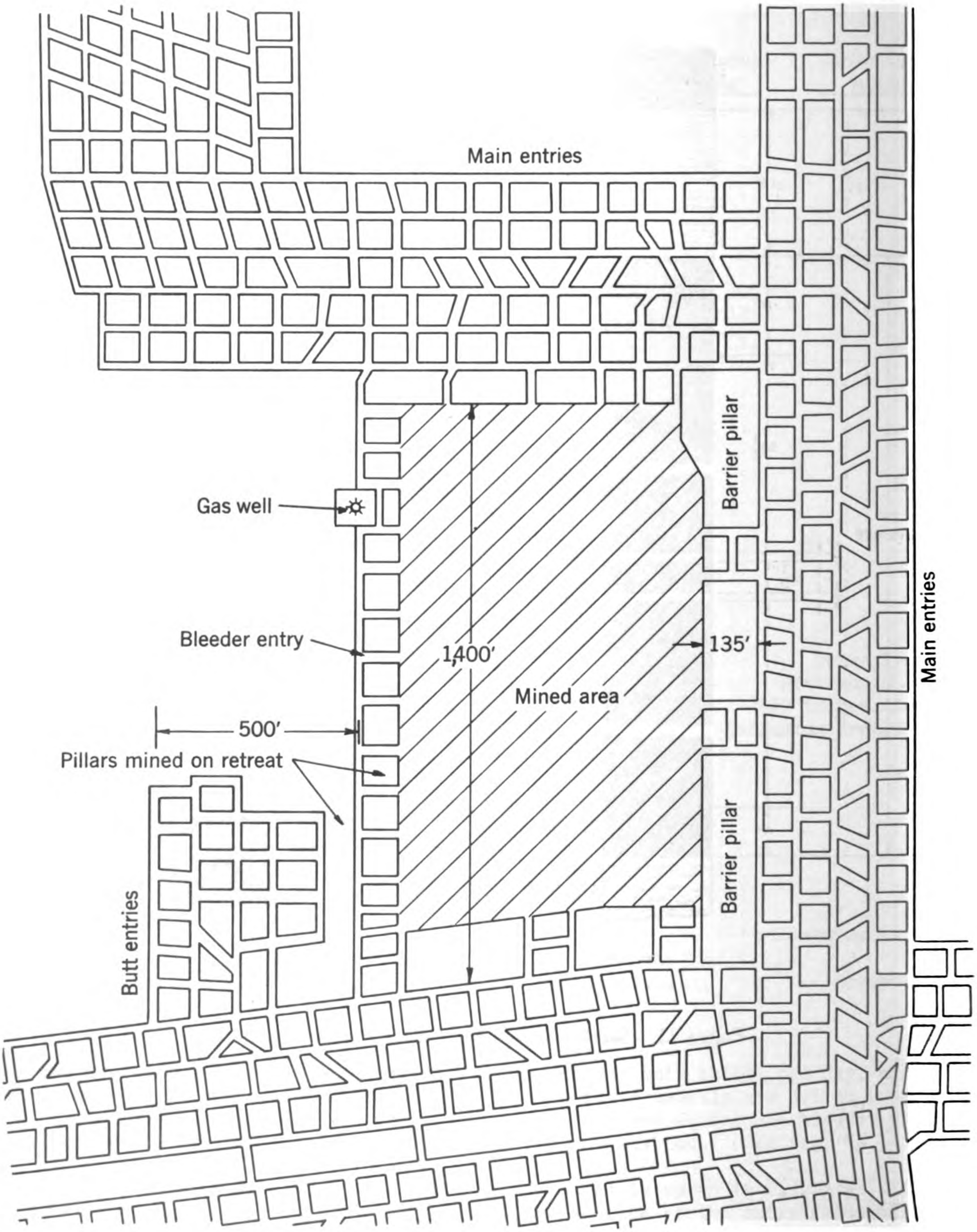

Figure 44. - Mining method at mine 14.

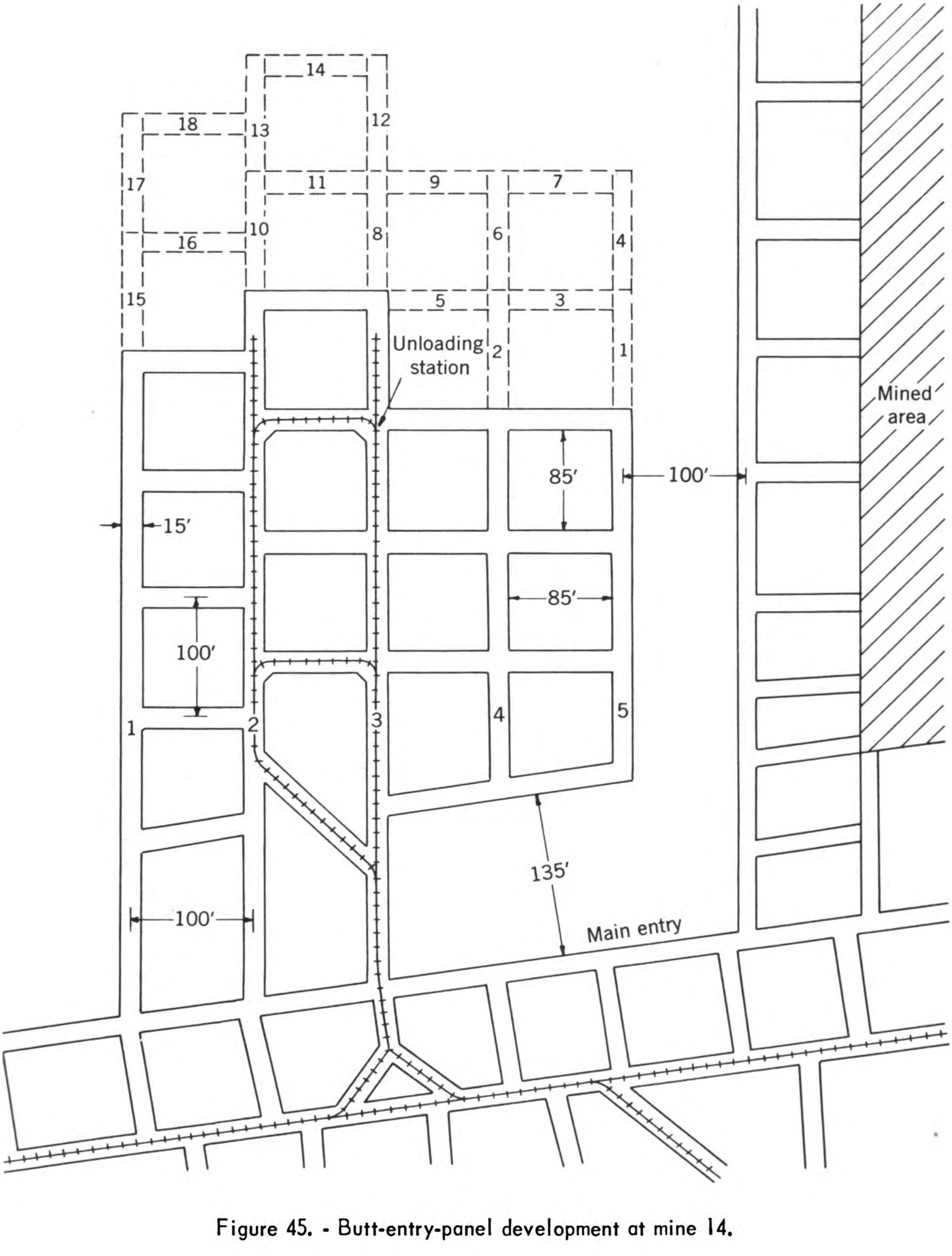

Figure 45. - Butt-entry-panel development at mine 14.

have been completed. Entries and crosscuts are driven 15 feet wide by the continuous-mining machine, which moves along the center of the place. The average advance of the continuous-mining machine is 40 feet per shift. Entries and crosscuts are roof bolted on 4-foot centers with 3/4-inch diameter bolts, 5 feet long and set against 6- by 6- by 3/8-inch steel plates. Wood crossbars, 6 inches in diameter, 14 feet long, and set on wood posts, are placed between each row of bolts. The continuous-mining machine is stopped when the operator reaches the last set of roof bolts or timbers and does not proceed until the entry or crosscut is bolted and timbered to the face. The unloading station for shuttle cars is established in the middle entry and is moved 200 feet to a new location as the entry advances.

A continuous-mining unit comprises 7 men, 1 continuous-mining machine, and two 6-ton-capacity, cable-reel shuttle cars. The shuttle cars transport the coal from the continuous-mining machine to the unloading station. The shuttle cars are each equipped with an elevating conveyor, which discharges the coal into 6-ton-capacity, steel mine cars. The shuttle-car operator spots the cars at the unloading station with a remote control car haul.

A continuous-mining crew consists of 7 men as follows:

Section foreman	1
Continuous-mining-machine operator	1
Shuttle-car operators	2
Timbermen	2
Electrician-mechanic	1
Total	7

Travel time at this mine is 1 hour 15 minutes; lunch time, 30 minutes; leaving 6 hours 15 minutes face time per shift. The average delay caused by mechanical failure is 1 hour, 16 percent of face time. Delay owing to shutdown for timbering amounts to 1 hour 30 minutes, 24 percent of face time. Actual productive time is 3 hours 45 minutes, 60 percent of face time. Maintenance, major repairs, moving, and other work necessary to keep the continuous-mining machine operating is done by two mechanics at the end of the third shift.

Classification of Employees

Classification	Shift[1/] 1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	2	2	2	6
Continuous-mining-machine operators	2	2	2	6
Shuttle-car operators	4	4	4	12
Timbermen	4	4	4	12
Electrician-mechanics	2	2	2	6
Total employees, continuous-mining units	14	14	14	42
Total employees, mobile-loading units	107	107	107	321
Supervisory and inspection	20	13	13	46
Other underground employees	69	23	24	116
Total underground employees	210	157	158	525
Total surface employees	79	23	17	119
Total surface and underground employees	289	180	175	644

1/ 1st shift - 6:00 a.m. to 2:00 p.m.
2d shift - 12:30 p.m. to 8:30 p.m.
3d shift - 7:00 p.m. to 3:00 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	21		79	
Hours per shift	8		8	
Unit shifts per day	6		30	
Average yield of clean coal...percent	68		68	
Average advance of continuous-mining machine per shift...feet	40		-	
Employees:				
In unit crews		42		321
Supervisory and other underground		34		128
Surface		25		94
Total charged to	101		543	
Average daily production, raw coal...tons	1,236		4,647	
Average production, raw coal per unit per shift...tons	206		154.9	
Average production, raw coal per man per shift on unit...tons	29.4		14.5	
Average production, raw coal per underground man shift...tons	16.2		10.3	
Average production, raw coal per payroll man shift...tons	12.2		8.5	

Mine 15

Location	Pennsylvania
Coal bed and thickness (fig. 46)...inches	Pittsburgh - 86 (76 inches mined)
Thickness of overburden (fig. 46)...feet	430
Production per day, raw coal...tons	8,750
Total employees	1,004
Type A continuous-mining machine:	
Entry development	1
Mobile-loading units	15
Shifts per day	2
System of mining (fig. 47)	Block, pillars extracted
Estimated recovery of coal (mined portion)...percent	96
Mainline haulage	Locomotive

Mining Method

One type A continuous-mining machine, operated two unit shifts per day, is used to develop a butt-entry panel. The butts are driven 14 feet wide in sets of 4 on 100-foot centers, developing blocks of coal 86 feet square, which are extracted on the retreat from the panel.

The plan for the development of a butt-entry panel is shown in figure 48. The solid lines in entries A to D, inclusive, show the advance of the entry faces at the end of a complete mining cycle. The broken lines show the advance of the entry faces at the end of the next complete mining cycle after cuts 1 to 14, inclusive, have been completed. Entries and crosscuts are driven 14 feet wide by the continuous-mining machine, which moves along the center of the place. The average advance

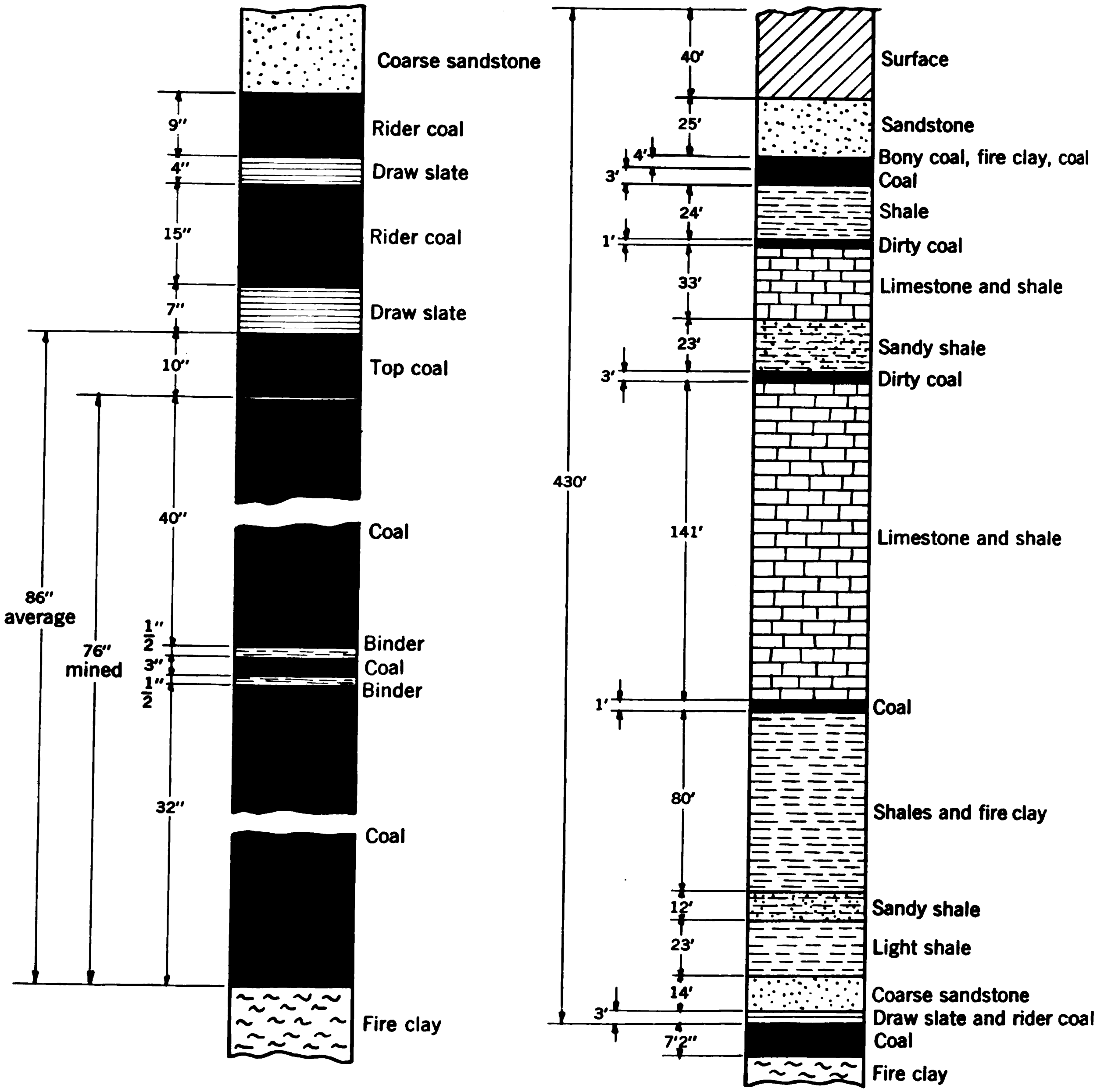

Figure 46. - Section of coal bed and overburden at mine 15.

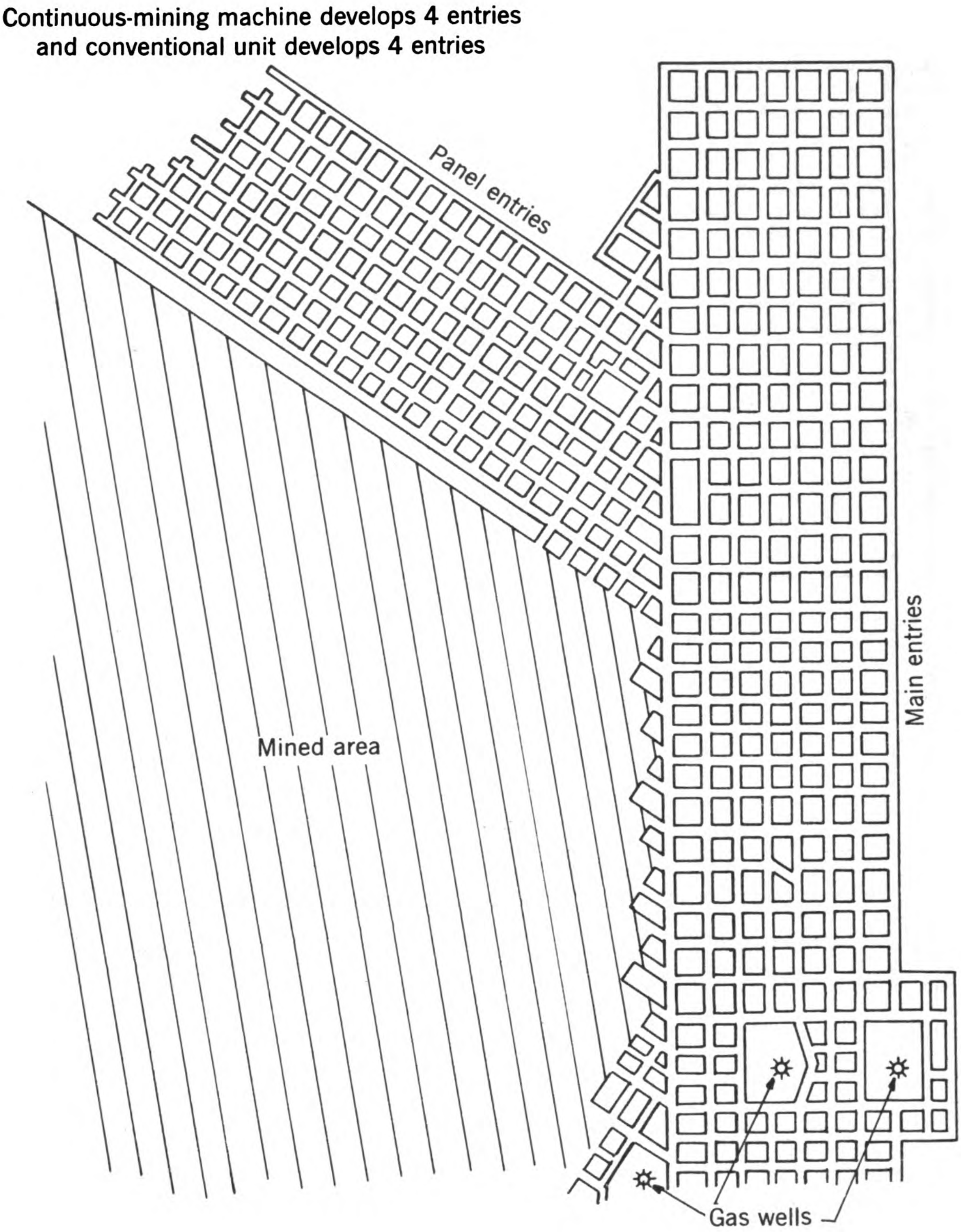
Continuous-mining machine develops 4 entries
and conventional unit develops 4 entries
Panel entries
Main entries
Mined area
Gas wells

Figure 47. - Mining method at mine 15.

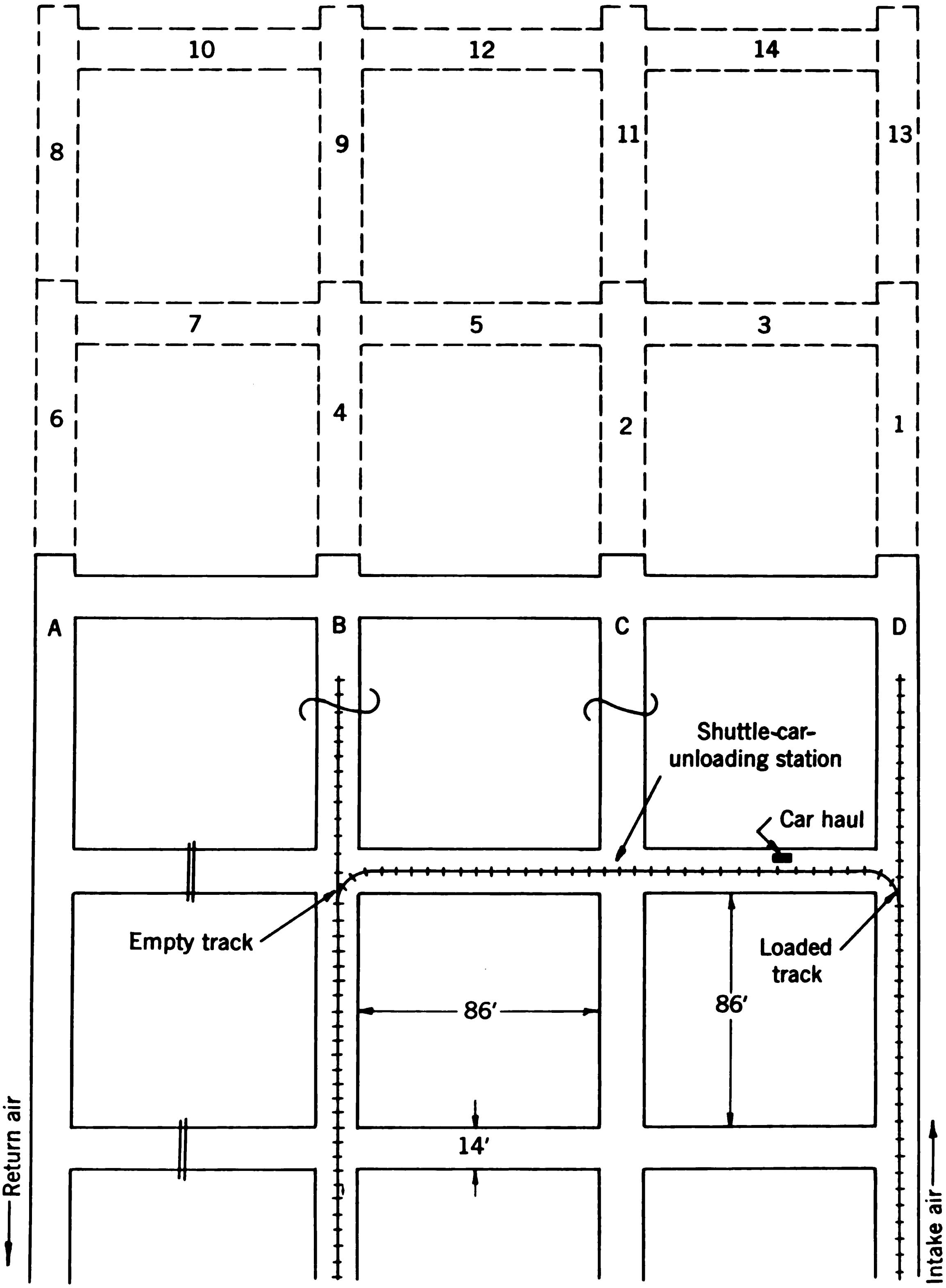

Figure 48. - Butt-entry-panel development at mine 15.

of the continuous-mining machine is 50 feet per shift. Entries and crosscuts are timbered on 5-foot centers with 6-inch-diameter wood crossbars 14 feet long set on wood posts. The continuous-mining machine is stopped when the operator reaches the last set of timbers and does not proceed until the entry or crosscut is timbered to the face. The unloading station for shuttle cars is moved 200 feet to a new location as the entry advances.

The plan for extracting pillars is shown in figure 49. Pillars A to J, inclusive, are mined after the butt entries have been driven 2,500 feet. A 45° pillar line is maintained on the retreat from the panel. The sequence of cuts in mining a pillar is shown by cuts 1 to 9, inclusive, in pillar F. Cuts 2 to 9, inclusive, usually are driven open end 16 feet wide, using wood crossbars on posts to support the roof. The cut is then widened to 21 feet on retreat. In each pillar (after cuts 5 and 9 have been made), the small fender of coal that remains generally is recovered.

A continuous-mining unit comprises 7 men, 1 continuous-mining machine, and two 6.5-ton cable-reel shuttle cars. One of the shuttle cars is used behind the continuous-mining machine as a surge car, and the other is used to transport the coal from the surge car to the unloading station. The shuttle car is equipped with an elevating conveyor, which discharges the coal into 6.5-ton-capacity, steel mine cars. The shuttle-car operator spots the mine cars at the unloading station with a remote-control car haul.

A continuous-mining crew consists of 7 men as follows:

Section foreman..............................	1
Continuous-mining-machine operator...........	1
Shuttle-car operators........................	2
Timbermen....................................	[1]2
Electrician-mechanic.........................	1
Total......................................	7

---

[1] Only one timberman on second shift

Travel time at this mine is 1 hour 5 minutes; lunch time, 30 minutes; leaving 6 hours 25 minutes face time per shift. The average delay caused by mechanical failure is 20 minutes, 5.2 percent of face time. Delay owing to shutdown for timbering amounts to 1 hour, 15.6 percent of face time. Actual productive time is 5 hours 5 minutes, 79.2 percent of face time. Maintenance, major repairs, and other work necessary to keep the continuous-mining machine operating is done by a mechanic on the third shift.

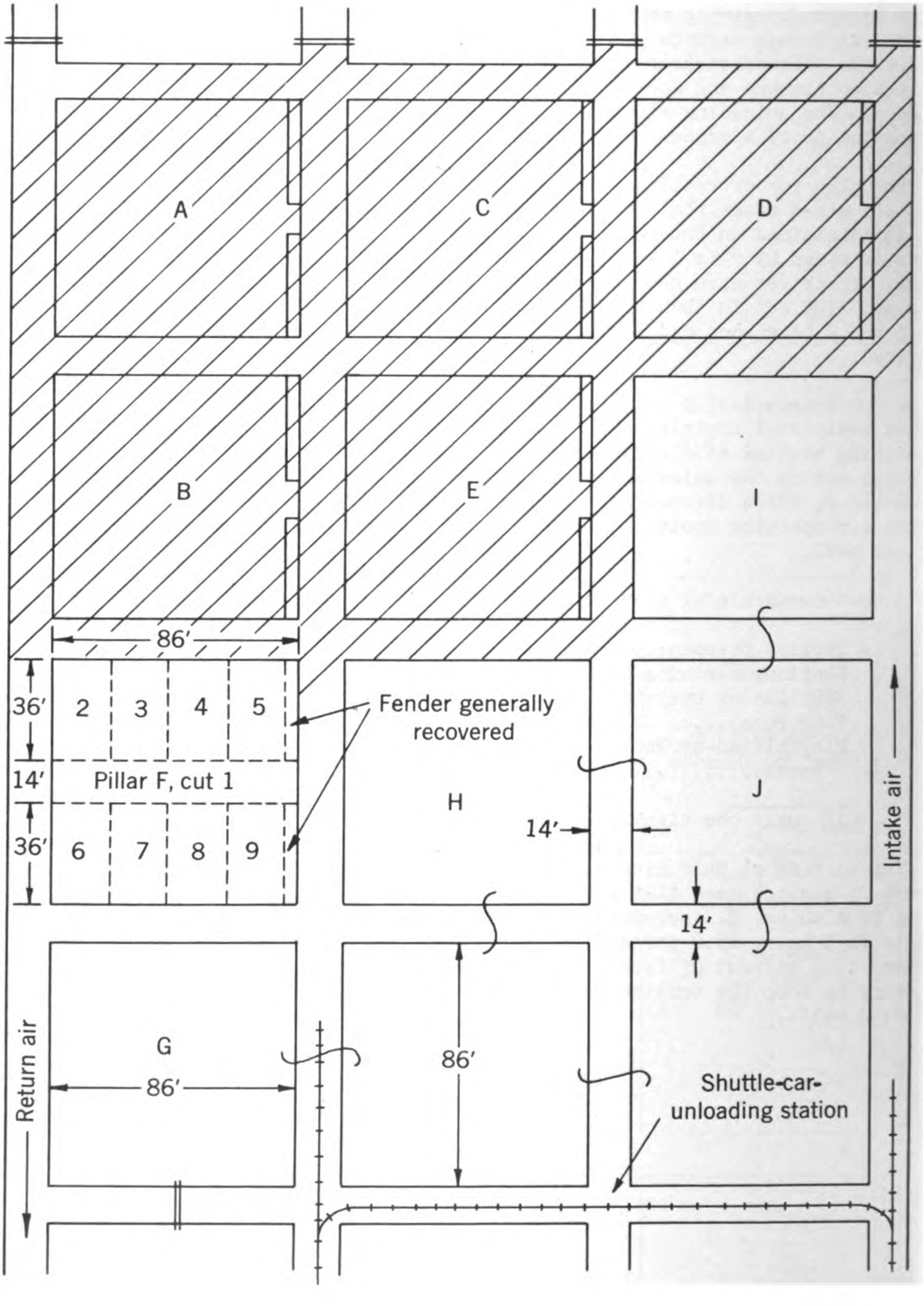

Figure 49. - Pillar extraction at mine 15.

Classification of Employees

Classification	Shift[1/] 1st	2d	3d	Total
Type A continuous-mining unit:				
Section foremen	1	1	-	2
Continuous-mining-machine operators	1	1	-	2
Shuttle-car operators	2	2	-	4
Timbermen	2	1	-	3
Electrician-mechanics	1	1	-	2
Total employees, continuous-mining unit	7	6	-	13
Total employees, mobile-loading units	255	225	-	480
Supervisory and inspection	7	2	7	16
Other underground employees	147	95	43	285
Total underground employees	416	328	50	794
Total surface employees	146	42	22	210
Total surface and underground employees	562	370	72	1,004

1/ 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 4:00 p.m. to 12:00 p.m.
3d shift - 11:00 p.m. to 7:00 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	4.8		95.2	
Hours per shift	8		8	
Unit shifts per day	2		30	
Average yield of clean coal ... percent	87		79.6	
Average advance of continuous-mining machine per shift ... feet	50		-	
Employees:				
In unit crews		13		480
Supervisory and other underground		13		288
Surface		9		201
Total charged to	35		969	
Average daily production, raw coal ... tons	420		8,330	
Average production, raw coal per unit per shift ... tons	210		277.7	
Average production, raw coal per man per shift on unit ... tons	32.3		17.4	
Average production, raw coal per underground man shift ... tons	16.2		10.8	
Average production, raw coal per payroll man shift ... tons	12.0		8.6	

Mine 16

Location..	West Virginia
Coal bed and thickness (fig. 50).............inches	Lower Kittanning - 48 to 59 (42 to 53 inches mined)
Thickness of overburden........................feet	100
Production per day, raw coal...................tons	1,111
Total employees.......................................	133
Type A continuous-mining machines:	
Room mining..	2
Type B continuous-mining machine:	
Entry development..................................	1
Hand-loading units....................................	3
Shifts per day..	3
System of mining (fig. 51)............................	Room-and-pillar, pillars not extracted
Estimated recovery of coal in place..........percent	80
Mainline haulage......................................	Locomotive - 30-inch belt

Mining Method

Two type A continuous-mining machines, operated 6 unit shifts per day, are used to develop rooms 27 feet wide in 300- by 250-foot blocks of coal. (See fig. 51.) Each machine is assigned a separate block to mine. The plan for mining rooms with the type A continuous-mining machine is shown by cuts 1 to 5, inclusive. (See fig. 52.) The room is opened 14 feet wide and advanced 250 feet. (Cuts 1 to 4.) A chain conveyor is placed along the left rib and extended every 12 feet of room advance. Crosscuts, 7 to 10 feet wide on 60-foot centers, are driven to the right and turned 45° from the room. After cuts 1 to 4 have been completed, the continuous-mining machine is turned around and mines a 13-foot cut from the left rib to complete the room. (Cut 5.) Posts are set on 5-foot centers, or closer, if needed, to support the roof.

The type A continuous-mining unit comprises 5-1/2 men, 1 continuous-mining machine, 1 chain conveyor, and one 26-inch belt. Coal from the continuous-mining machine is discharged onto the chain conveyor, which is not moved until mining is completed in the room. The chain conveyor discharges onto a 26-inch panel belt, which discharges the coal into mine cars in the main entries.

The type A continuous-mining crew consists of 5-1/2 men as follows:

Foreman..	1/2
Continuous-mining-machine operator..................	1
Continuous-mining-machine helper....................	1
Timbermen..	2
Boom man...	1/2
Electrician-mechanic.................................	1/2
Total..	5-1/2

One type B continuous-mining machine, operated two unit shifts per day, is used to develop a set of panel entries in a new section of the mine. The plan for developing three panel entries with the type B continuous-mining machine is shown by cuts 1 to 19, inclusive. (See fig. 53.) The solid lines represent the coal faces at the beginning of the mining cycle. The broken lines represent the coal faces at the end of the mining cycle after cuts 1 to 19 have been mined. The entries are driven 18

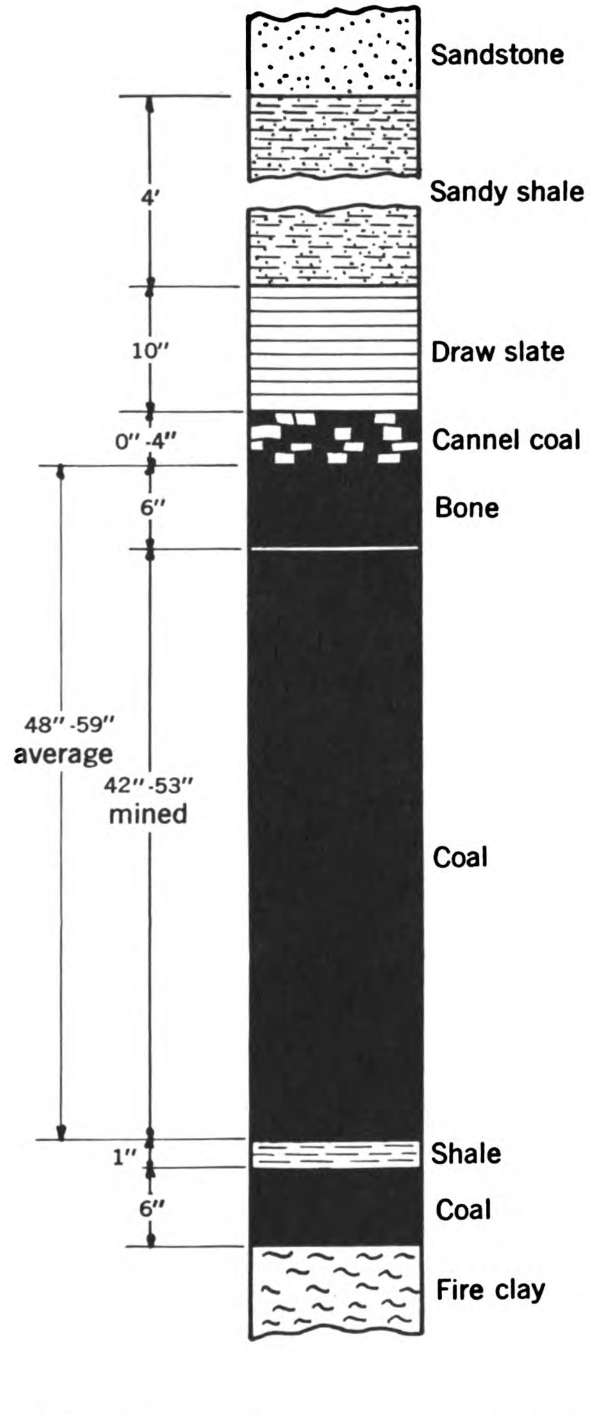

Figure 50. - Section of roof, coal bed, and bottom at mine 16.

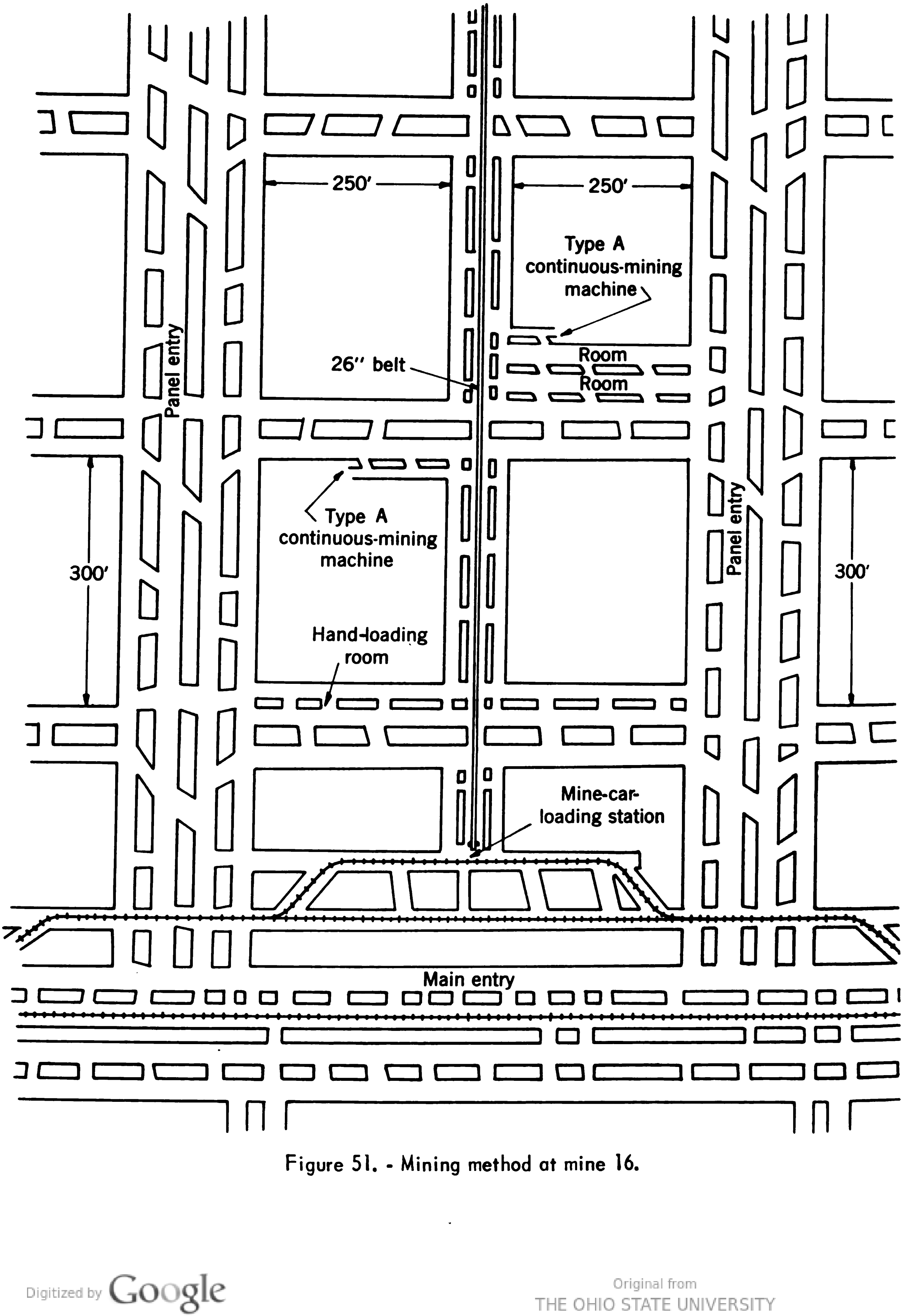

Figure 51. - Mining method at mine 16.

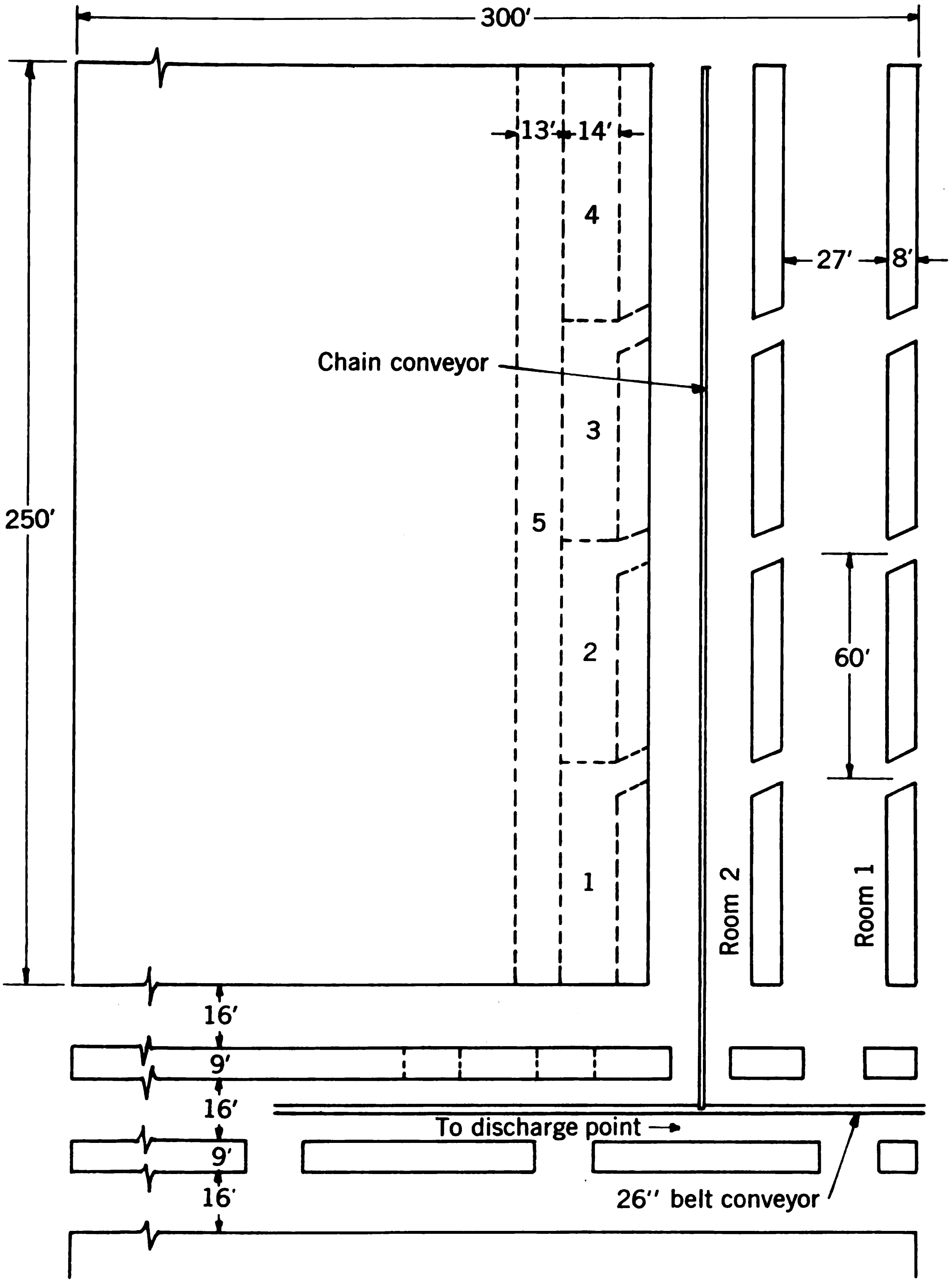

Figure 52. - Room mining with type A continuous-mining machine at mine

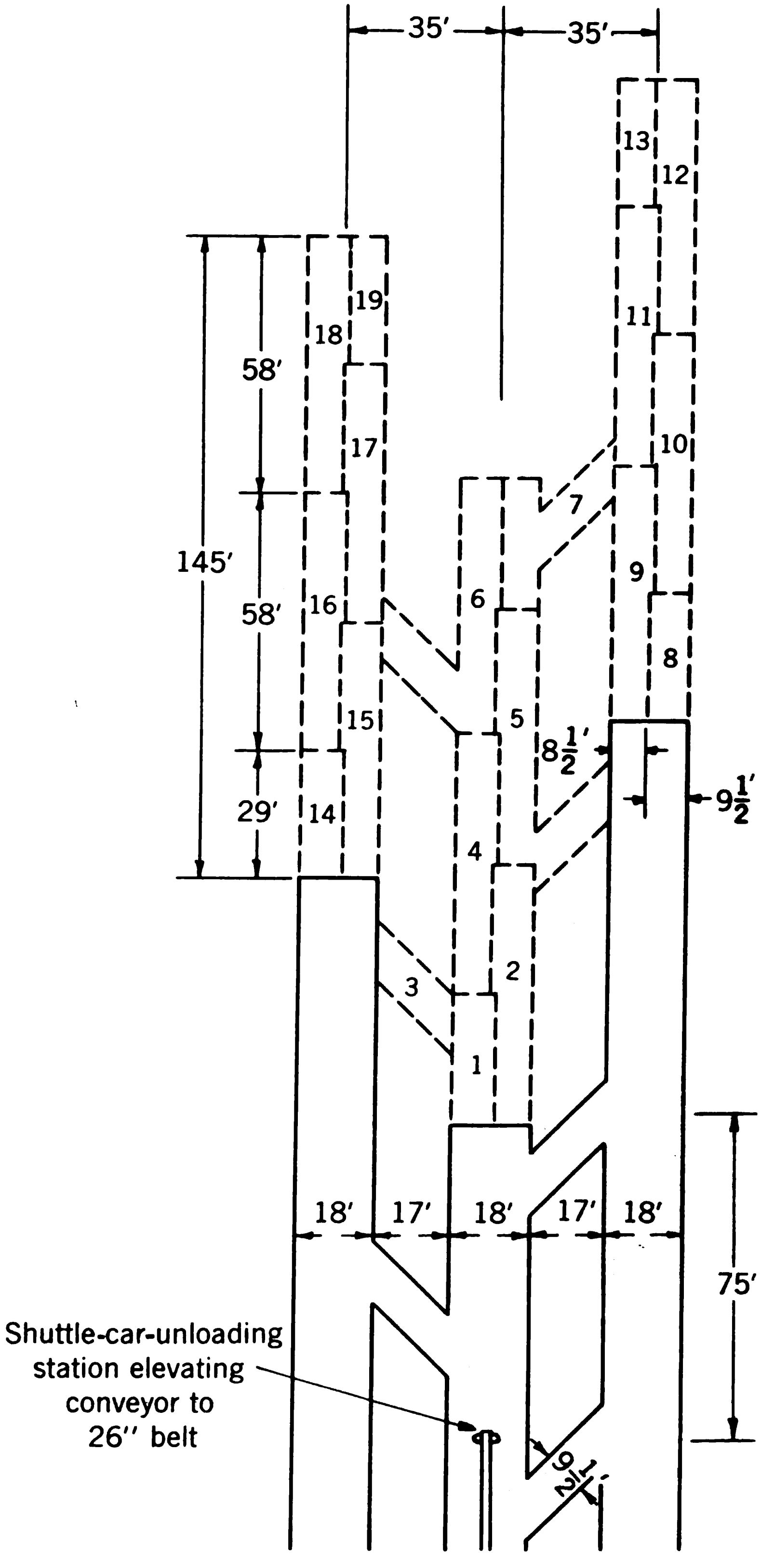

Figure 53. - Main-entry development with type B continuous-mining machine at mine 16.

feet wide by making alternate cuts 9-1/2 and 8-1/2 feet wide. Crosscuts are turned 45° from the center entry and driven 9-1/2 feet wide on 75-foot centers. All entries are roof bolted on 5-foot centers with 5/8-inch bolts, 36 inches long set against 6- by 6- by 3/8-inch steel plates. The average advance of the type B continuous-mining machine in an 18-foot entry is 40 feet per shift.

A type B continuous-mining unit comprises 8 men, 1 type B continuous-mining machine, 2 shuttle cars, 1 elevating conveyor, one 26-inch belt, and 1 portable roof-bolting machine. Two shuttle cars transport the coal from the continuous-mining machine to an elevating conveyor, which discharges onto a 26-inch belt. The coal is conveyed by the 26-inch belt to a 30-inch main belt, which transports the coal to the tipple.

The type B continuous-mining crew consists of 8 men, as follows:

Section foreman	1
Continuous-mining-machine operator	1
Continuous-mining-machine helper	1
Shuttle-car operators	2
Timberman	1
Beltman	1
Electrician-mechanic	[1] 1
Total	8

---

[1] Electrician-mechanic on first shift only.

Travel time at this mine is 50 minutes; lunch time, 30 minutes; leaving 6 hours 40 minutes face time per shift. The average delay caused by mechanical failure is 1 hour 4 minutes, 16 percent of face time. Other delays as retracting or maneuvering the continuous-mining machine, power failure, and waiting on empty cars amount to 32 minutes, 8 percent of face time. Actual productive time is 5 hours 4 minutes, 76 percent of face time. All repairs, maintenance, moving, and other work necessary to keep the continuous-mining unit operating are done on shift and between shifts.

Classification of Employees

		Shift[1]		
Classification	1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	1	1	1	3
Continuous-mining-machine operators	2	2	2	6
Continuous-mining-machine helpers	2	2	2	6
Timbermen	4	4	4	12
Boom men	1	1	1	3
Electrician-mechanics	1	1	1	3
Total employees, type A continuous-mining units	11	11	11	33
Type B continuous-mining unit:				
Section foremen	1	1	-	2
Continuous-mining-machine operators	1	1	-	2
Continuous-mining-machine helpers	1	1	-	2
Shuttle-car operators	2	2	-	4
Timbermen	1	1	-	2
Beltmen	1	1	-	2
Electrician-mechanic	1	-	-	1
Total employees, type B continuous-mining unit	8	7	-	15

See footnote at end of tabulation on following page.

	Shift[1]			
Classification	1st	2d	3d	Total
Total employees, continuous-mining units	19	18	11	48
Total employees, hand-loading units	26	13	5	44
Supervisory and inspection	2	1	-	3
Other underground employees	14	2	2	18
Total underground employees	61	34	18	113
Total surface employees	13	5	2	20
Total surface and underground employees	74	39	20	133

---

[1] 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 3:00 p.m. to 11:00 p.m.
3d shift - 11:00 p.m. to 7:00 a.m.

Summary

	Continuous mining		Conventional mining
	Type A	Type B	Hand loading onto chain conveyors
Percent of mine production	56.8	18.2	25
Hours per shift	8	8	8
Unit shifts per day	6	2	6
Average yield of clean coal......percent	99	99	99
Average advance of continuous-mining machine per shift.....feet	50	40	-
Employees:			
In unit crews	33	15	44
Supervisory and other underground	12	4	5
Surface	11	4	5
Total charged to	56	23	54
Average daily production, raw coal..tons	631	202	278
Average production, raw coal per unit per shift.....tons	105.2	101	46.3
Average production, raw coal per man per shift on unit.....tons	19.1	13.5	6.3
Average production, raw coal per underground man shift.....tons	14	10.6	5.7
Average production, raw coal per payroll man shift.....tons	11.3	8.8	5.1

Mine 17

Location	West Virginia
Coal bed and thickness (fig. 54).....inches	No. 2 Gas - 54
Thickness of overburden.....feet	0 to 600
Production per day, raw coal.....tons	700
Total employees	55
Type A continuous-mining machine:	
Entry development	1
Mobile-loading unit	1
Shifts per day	2
System of mining (fig. 55)	Room-and-pillar, pillars extracted
Estimated recovery of coal in place.....percent	-
Mainline haulage	30-inch belt

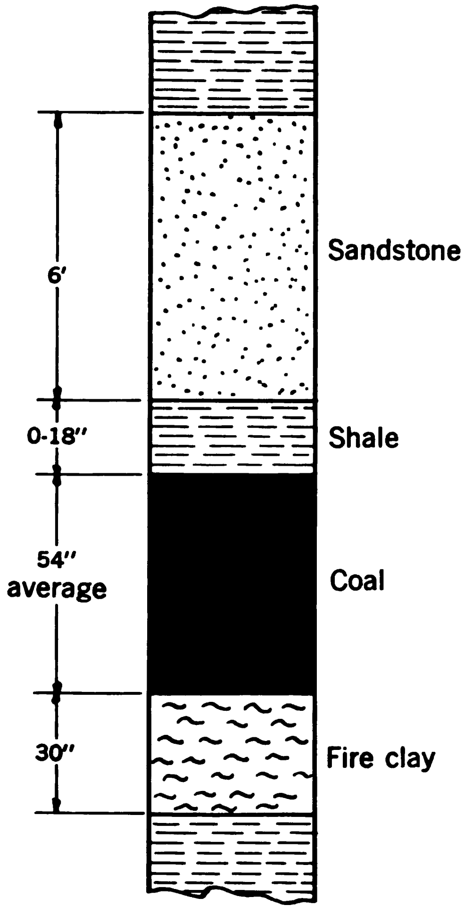

Figure 54. - Section of roof, coal bed, and bottom at mine 17.

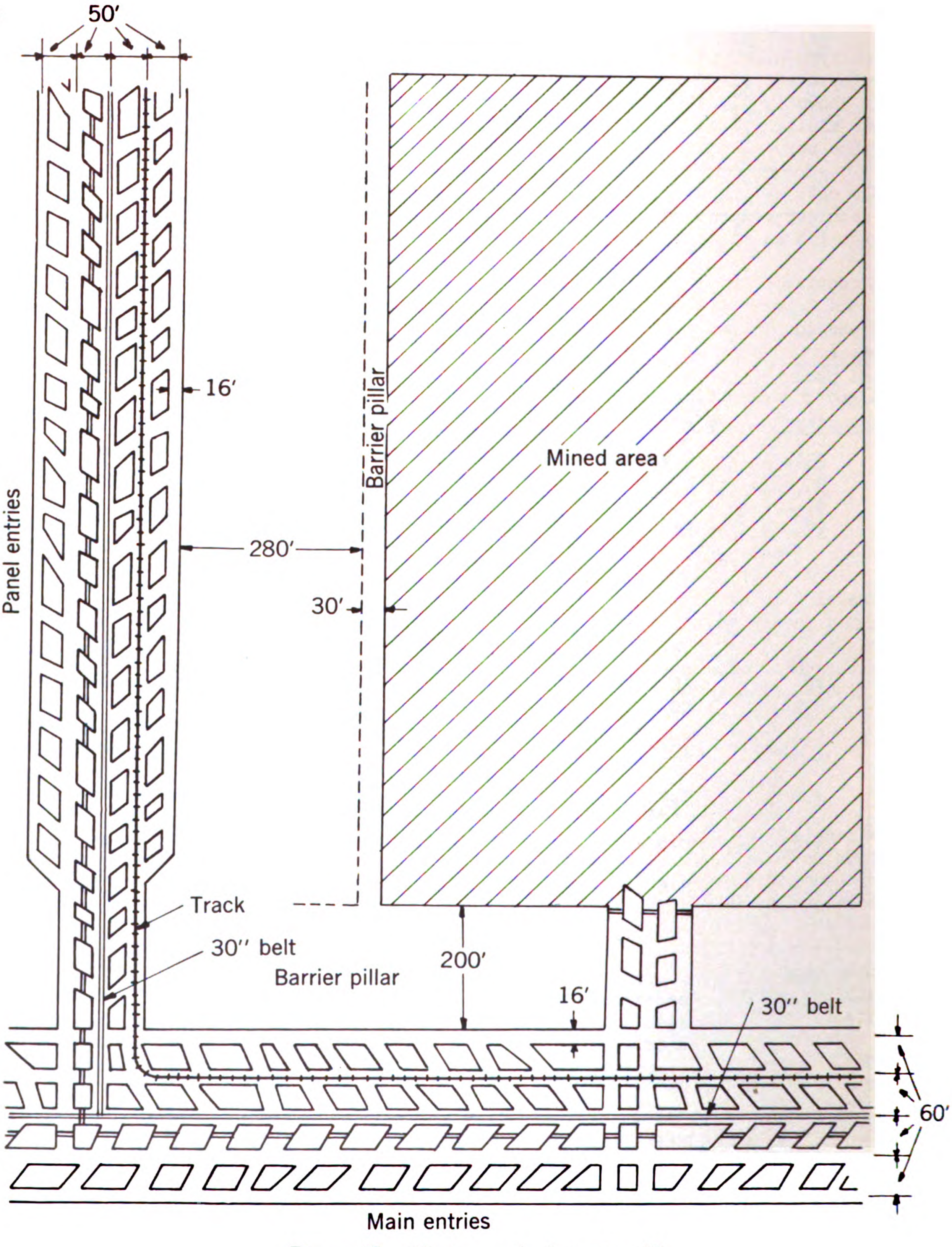

Figure 55. - Mining method at mine 17.

Mining Method

One type A continuous-mining machine, operated two unit shifts per day, is used to develop a set of three panel entries. The plan followed by the continuous-mining unit is shown in figure 56. The solid lines show the coal faces at the end of a complete mining cycle. The broken lines show the advance of the coal faces at the end of the next complete mining cycle after cuts 1 to 5 have been mined.

All entries, crosscuts, and rooms are timbered; using wood props with 3- by 8- by 24-inch cap pieces. A single row of props is set on 6-foot centers 2 or 3 feet from each rib as mining progresses.

A continuous-mining unit comprises 6-1/2 men, 1 type A continuous-mining machine, and 2 cable-reel shuttle cars. One 3-1/2-ton-capacity shuttle car is used behind the continuous-mining machine as a surge car; and the other car transports the coal from the surge car to the 30-inch belt conveyor.

A continuous-mining crew consists of 6-1/2 men as follows:

Section foreman..................................	1
Continuous-mining-machine operator...............	1
Shuttle-car operators............................	2
Timbermen..	2
Electrician-mechanic.............................	1/2
Total..	6-1/2

Travel time at this mine is 20 minutes; lunch time, 30 minutes; leaving 7 hours 10 minutes face time per shift. The average delay caused by mechanical failure is 72 minutes, 16.7 percent of face time. Other delays, such as retracting or maneuvering the continuous-mining machine, power failure, and shuttle-car delays, amount to 18 minutes, 4.2 percent of face time. Actual productive time is 5 hours 40 minutes, 79.1 percent of face time. The continuous-mining unit is serviced and repaired by an electrician-mechanic on and between shifts.

Classification of Employees

Classification	Shift[1/] 1st	2d	Total
Type A continuous-mining unit:			
Section foremen..	1	1	2
Continuous-mining-machine operators......................	1	1	2
Shuttle-car operators....................................	2	2	4
Timbermen..	2	2	4
Electrician-mechanic.....................................	1/2	1/2	1
Total employees, continuous-mining unit................	6-1/2	6-1/2	13
Total employees, mobile-loading unit...................	11-1/2	1/2	12
Supervisory and inspection...............................	2	1	3
Other underground employees..............................	6	3	9
Total underground employees............................	26	11	37
Total surface employees................................	18	-	18
Total surface and underground employees..............	44	11	55

[1/] 1st shift - 6:10 a.m. to 2:10 p.m.
2d shift - 4:30 p.m. to 12:30 a.m.

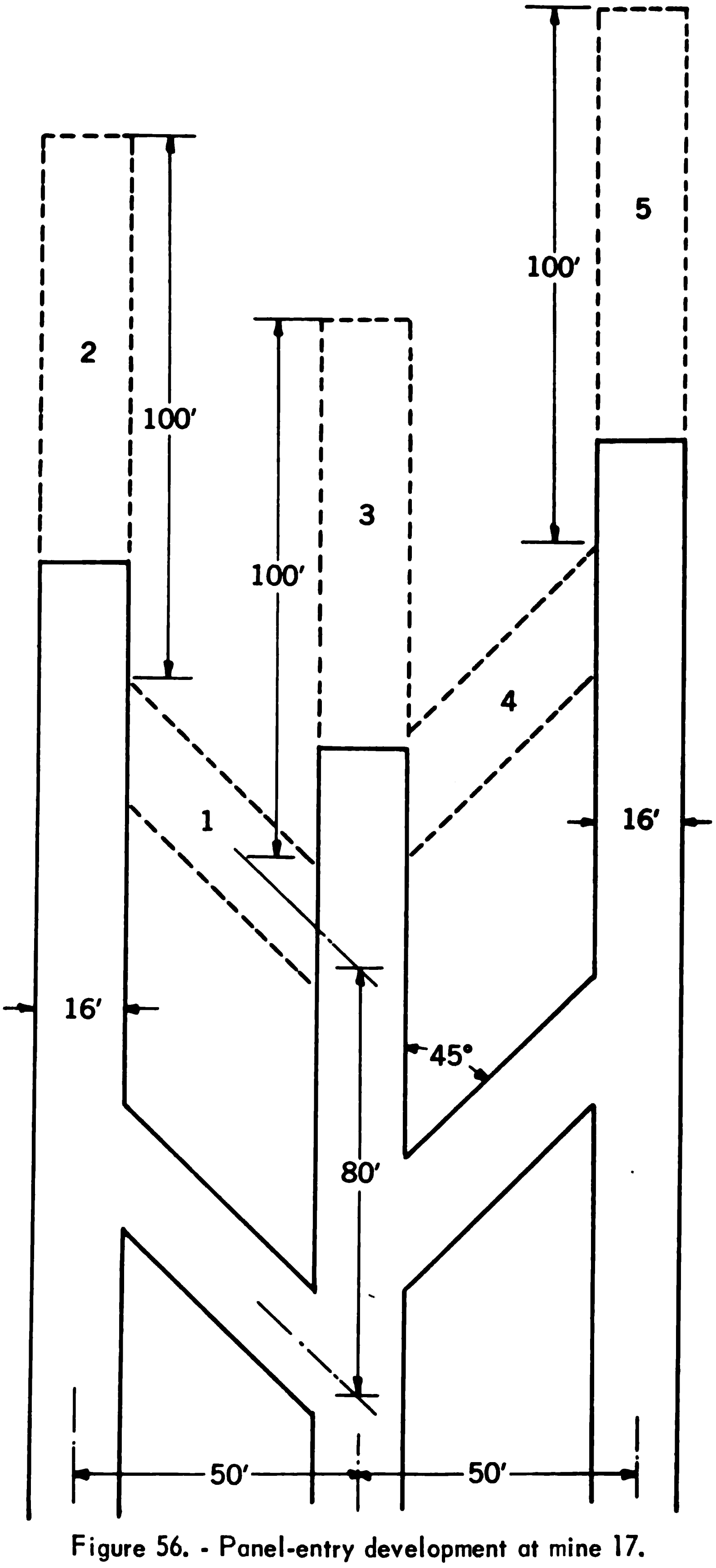

Figure 56. - Panel-entry development at mine 17.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	71.5		28.5	
Hours per shift	8		8	
Unit shifts per day	2		1	
Average yield of clean coal, percent	92		92	
Average advance of continuous-mining machine per shift, feet	75		-	
Employees:				
In unit crews		13		12
Supervisory and other underground		9		3
Surface		13		5
Total charged to	35		20	
Average daily production, raw coal, tons	500		200	
Average production, raw coal per unit per shift, tons	250		200	
Average production, raw coal per man per shift on unit, tons	38.5		16.7	
Average production, raw coal per underground man shift, tons	22.7		13.3	
Average production, raw coal per payroll man shift, tons	14.3		10.0	

Mine 18

Location	West Virginia
Coal bed and thickness (fig. 57), inches	Sewickley - 72
Thickness of overburden (fig. 57), feet	322
Production per day, raw coal, tons	2,609
Total employees	140
Type B continuous-mining machine:	
Entry development Room mining	1
Mobile-loading unit	1
Shifts per day	3
System of mining (fig. 58)	Block, pillars extracted
Estimated recovery of coal in place, percent	68 to 92
Mainline haulage	Locomotive

Mining Method

One type B continuous-mining machine, operated three unit shifts per day, is used for all development and mining of pillars on retreat. The plan for development is shown in figure 59. The solid line in entries 1, 2, 3, 4, and 5 shows the advance of the face at the end of a complete cycle of operations. The broken line represents the advance of the entries at the end of the next complete cycle of operations. The sequence of cuts for a complete cycle of entry advance follows: First, the continuous-mining machine is advanced 70 feet in entry 5 (cut A) and then is retracted and moved to entry 4. Entries 4, 3, and 2 are advanced in similar manner by cuts B, C, and D. Then the crosscut from entry 2 to entry 1 is driven for cut E. Entry 1 is advanced 70 feet by cut F, and then the continuous-mining machine is

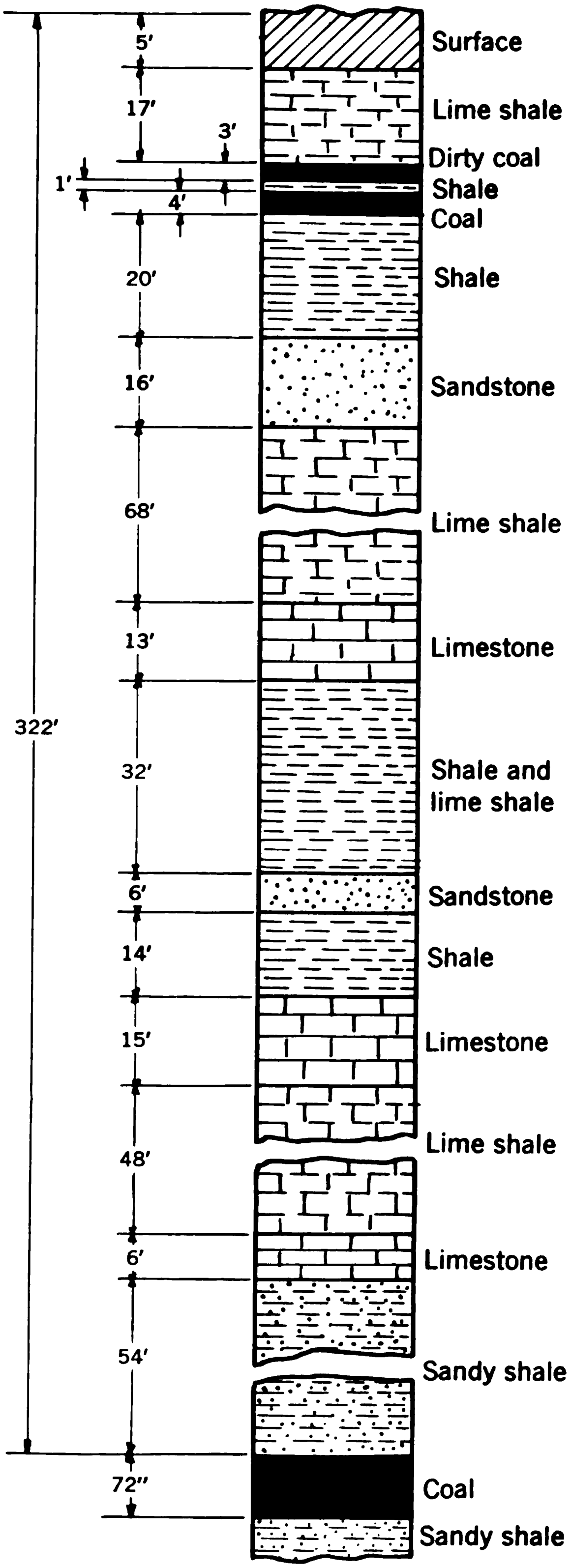

Figure 57. - Section of coal bed and overburden at mine 18.

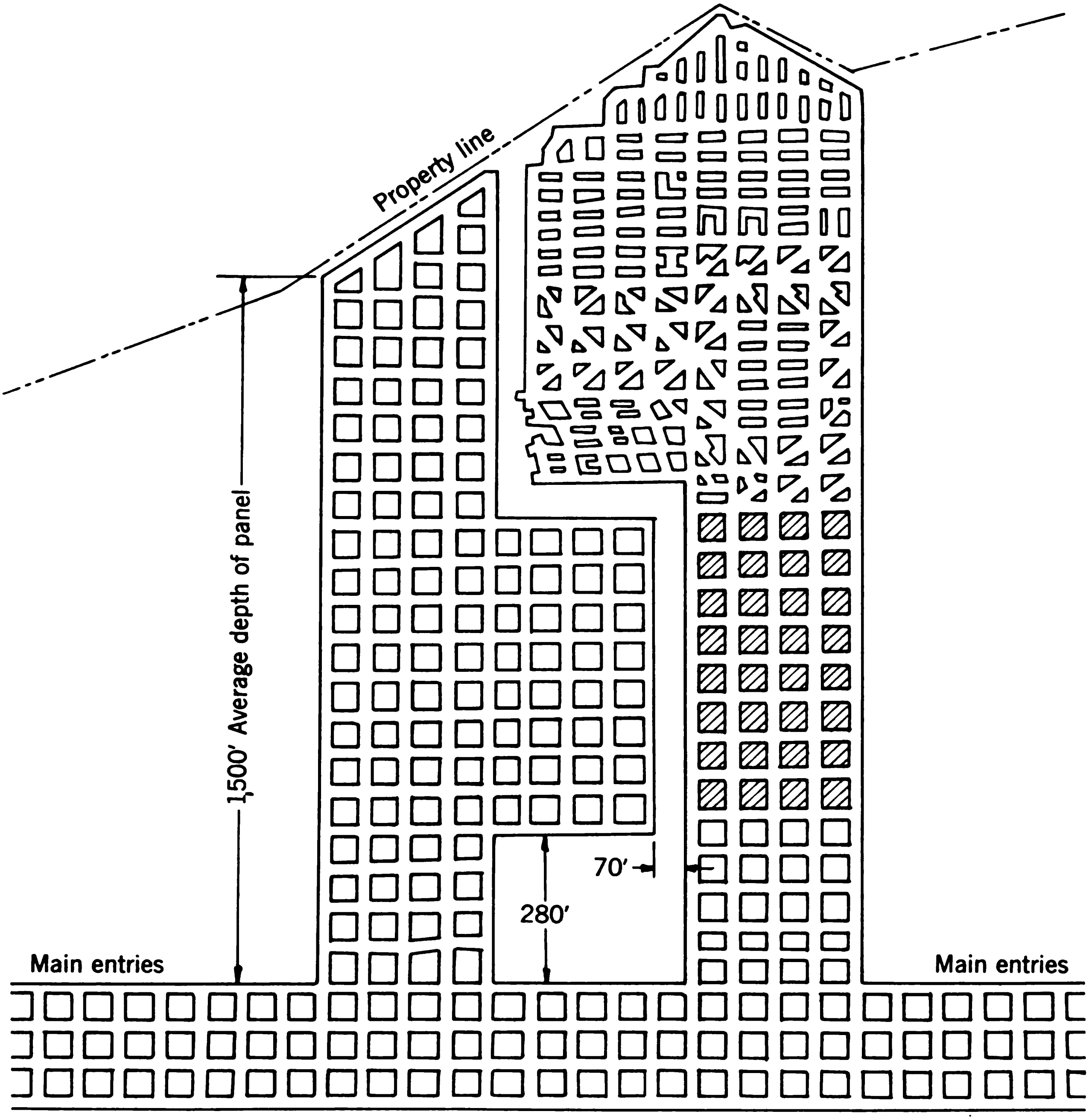

Figure 58. - Mining method at mine 18.

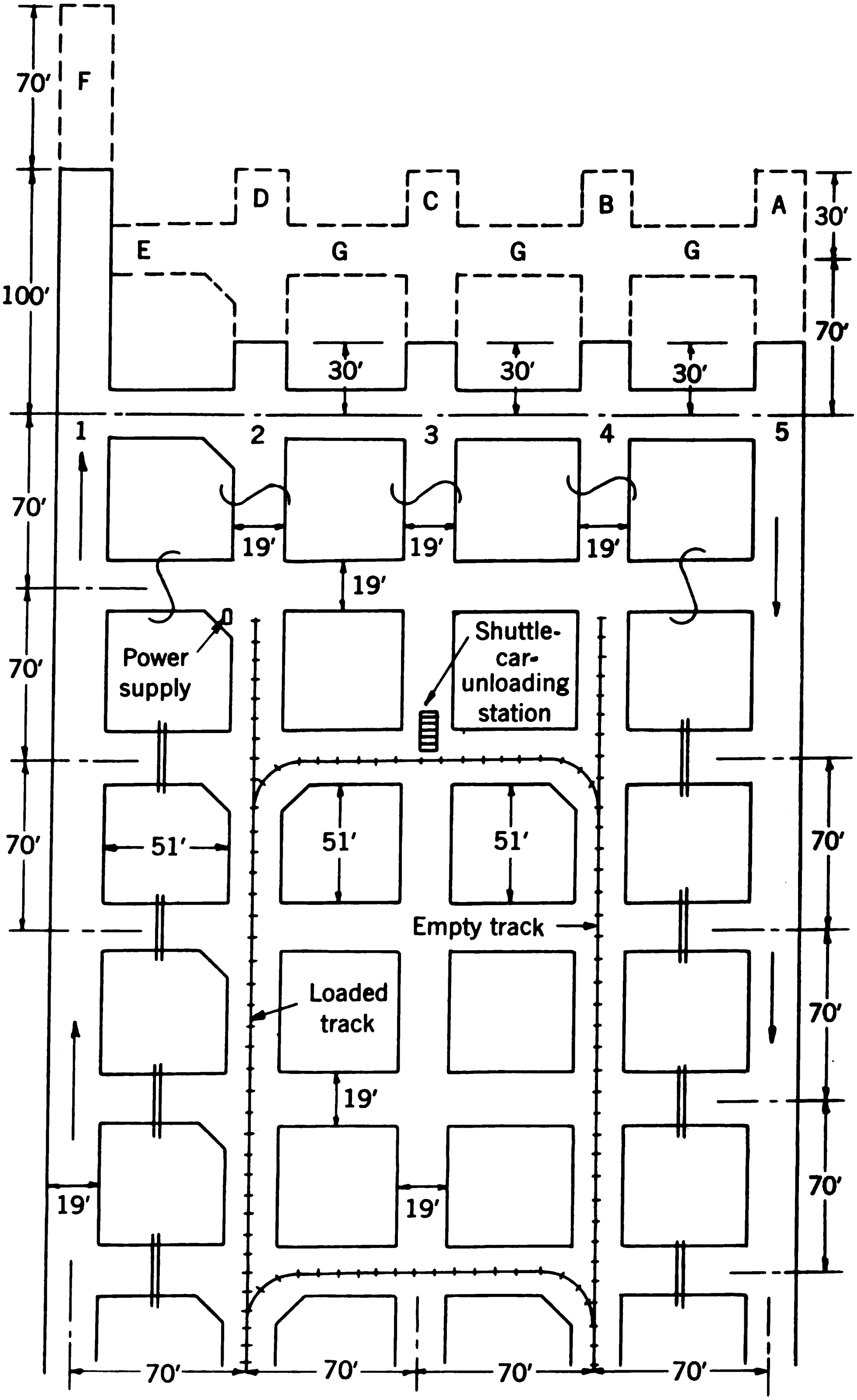

Figure 59. - Butt-entry-panel development at mine 18.

retracted and moved through the crosscut (cut E). The crosscuts from entry 2 to entry 5 (cut G) are driven then to complete the cycle of operation. The average advance of the continuous-mining machine is 110 feet per shift. Entries and crosscuts are driven 19 feet wide by making alternate cuts 9-1/2 feet wide, as shown by sequence of cuts, figure 60.

Steel timber jacks, set on 4-foot centers with 3- by 5- by 23-inch wood cap pieces, are used for safety posts to protect men and equipment. These timber jacks are reset near the opposite rib for each alternate cut. (See fig. 60.) Permanent timbering generally is not required for roof support.

The pillars are partly or completely mined on retreat by splitting either through the center or diagonally. (See fig. 58.) Recovery of coal in place will vary from 68 to 92 percent.

A continuous-mining unit comprises 8 men, 1 continuous-mining machine, 1 mobile-loading machine, and 3 cable-reel shuttle cars. The continuous-mining machine deposits the coal on the floor, which provides adequate surge capacity and allows the continuous-mining machine to operate with a minimum of shuttle-car haulage delays. The mobile-loading machine reloads the coal into 6-ton-capacity shuttle cars, which transport the coal to the unloading station. The shuttle cars are equipped with elevating conveyors, which discharge the coal into 5-ton, steel mine cars. Cars are spotted by the shuttle-car operator at the unloading station with a remotely controlled hoist.

A continuous-mining crew consists of 8 men as follows:

Section foreman................................	1
Continuous-mining-machine operator..............	1
Loading-machine operator........................	1
Shuttle-car operators...........................	3
Timbermen.......................................	2
Total.......................................	8

Travel time at this mine is 1 hour; lunch time, 30 minutes; leaving 6 hours 30 minutes face time per shift. The average delay caused by machine stoppages to permit lubrication and mechanical failures is 1 hour 30 minutes, 23 percent of face time. Other loading delays, as retracting or maneuvering the continuous-mining machine, cable handling, timbering, etc., amount to 2 hours, 31 percent of face time. Actual face loading is 3 hours, 46 percent of face time. All repairs, maintenance, moving, and other work necessary to keep the unit operating are done by a mechanic at the beginning of the shift or, when necessary, on shift.

Classification of Employees

Classification	Shift[1/] 1st	2d	3d	Total
Type B continuous-mining unit:				
Section foremen....................................	1	1	1	3
Continuous-mining-machine operators..................	1	1	1	3
Loading-machine operators..............................	1	1	1	3
Shuttle-car operators..................................	3	3	3	9
Timbermen..	2	2	2	6
Total employees, continuous-mining unit..........	8	8	8	24

See footnote at end of tabulation on following page.

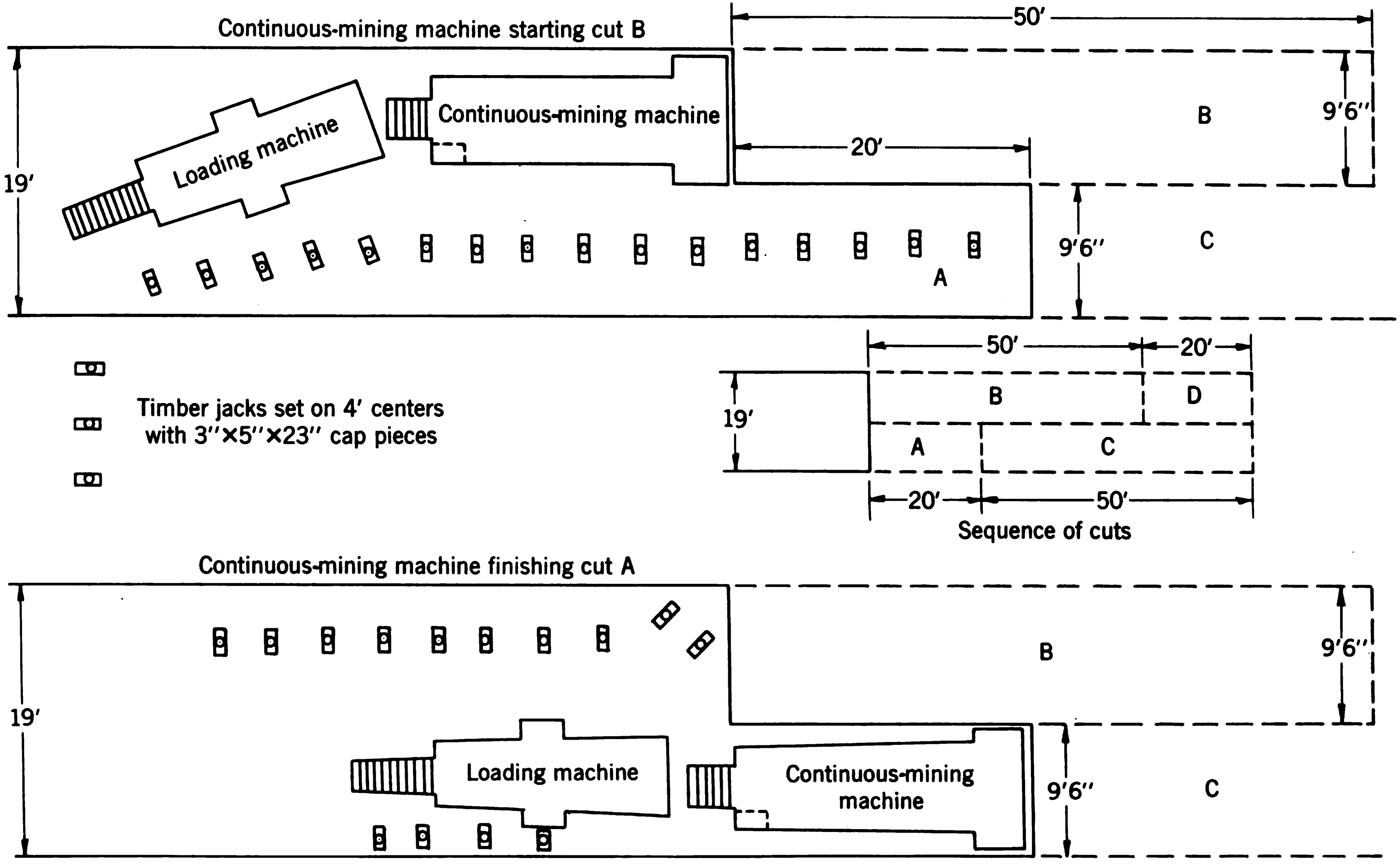
Continuous-mining machine starting cut B
50'
20'
9'6"
9'6"
19'
Loading machine
Continuous-mining machine
A
B
C
Timber jacks set on 4' centers with 3"×5"×23" cap pieces
50'
20'
19'
B
D
A
C
20'
50'
Sequence of cuts
Continuous-mining machine finishing cut A
19'
Loading machine
Continuous-mining machine
B
C
9'6"
9'6"

Figure 60. - Timbering plan and sequence of cuts in mining at mine 18.

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Classification	Shift[1] 1st	2d	3d	Total
Total employees, mobile-loading unit	12	12	12	36
Supervisory and inspection	1	1	1	3
Other underground employees	13	26	13	52
Total underground employees	34	47	34	115
Total surface employees	7	12	6	25
Total surface and underground employees	41	59	40	140

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[1] 1st shift - 11:00 p.m. to 7:00 a.m.
2d shift - 7:00 a.m. to 3:00 p.m.
3d shift - 3:00 p.m. to 11:00 p.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	65		35	
Hours per shift	8		8	
Unit shifts per day	3		3	
Average yield of clean coal ... percent	92		92	
Average advance of continuous-mining machine per shift ... feet	110		-	
Employees:				
In unit crews		24		36
Supervisory and other underground		36		19
Surface		16		9
Total charged to	76		64	
Average daily production, raw coal ... tons	1,696		913	
Average production, raw coal per unit per shift ... tons	565		304	
Average production, raw coal per man per shift on unit ... tons	70.6		25.3	
Average production, raw coal per underground man shift ... tons	28.3		16.6	
Average production, raw coal per payroll man shift ... tons	22.3		14.3	

Mine 19

Location	West Virginia
Coal bed and thickness (fig. 61) ... inches	Pittsburgh - 85 (73 inches mined)
Thickness of overburden ... feet	530
Production per day, raw coal ... tons	5,217
Total employees	420
Type A continuous-mining machine:	
Entry development	1
Mobile-loading units	5
Shifts per day	3
System of mining (fig. 62)	Room-and-pillar, pillars not extracted
Estimated recovery of coal in place ... percent	52
Mainline haulage	Locomotive

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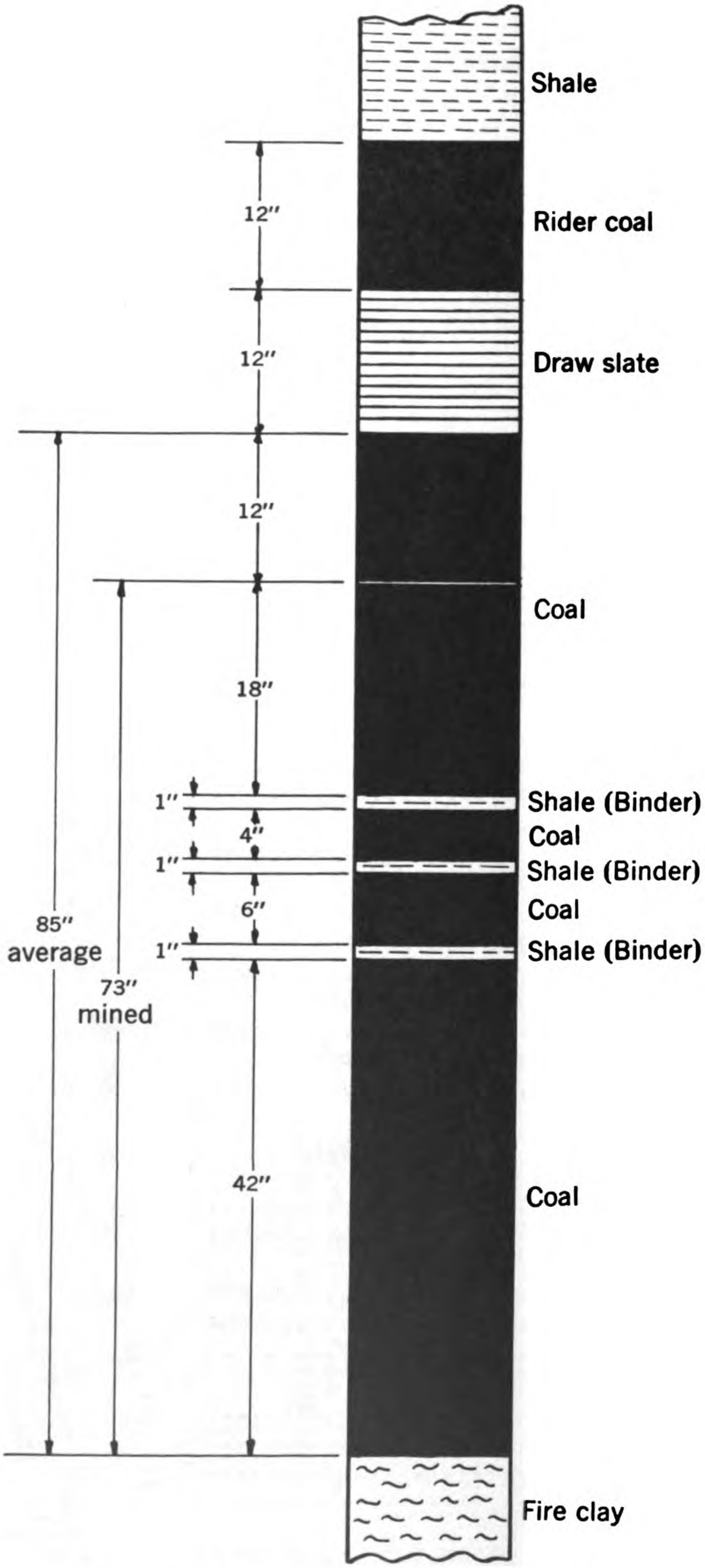

Figure 61. - Section of coal bed at mine 19.

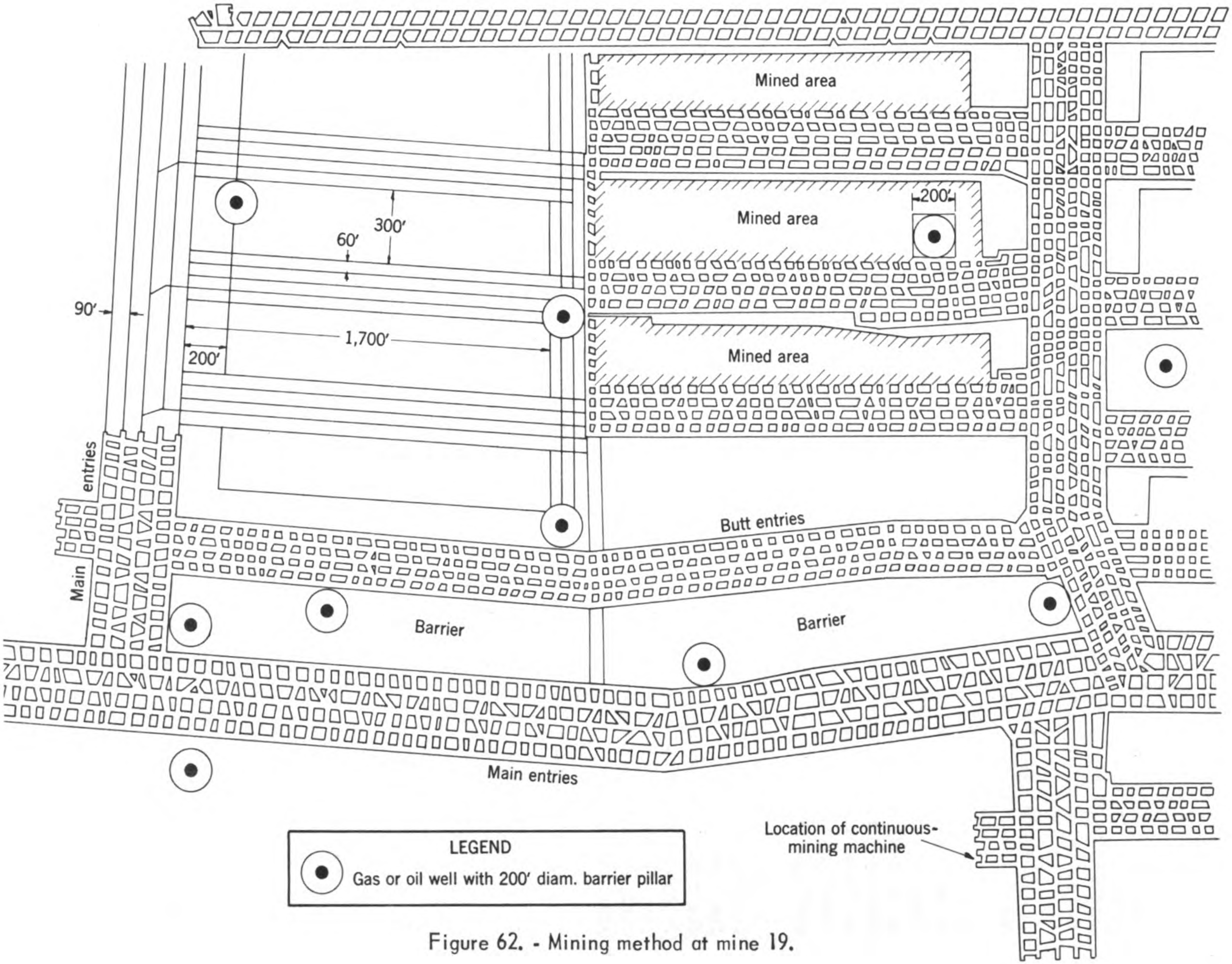

Figure 62. - Mining method at mine 19.

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Mining Method

Two type A continuous-mining machines, one operated three unit shifts per day while the other is in reserve, are being used temporarily to develop a set of butt entries. Usually, the continuous-mining machine is operated in room development only and will be so employed after the butt entries are developed. Rooms are driven 16 feet wide on 25-foot centers to a depth of 300 feet.

The plan for the development of the butt entries is shown in figure 63. The solid lines in entries 1, 2, 3, 4, and 5 represent the advance of the face at the end of a complete cycle of operation. The broken lines represent the advance of the face at the end of the succeeding cycle of operations (cuts 1 to 36). Entries and crosscuts are driven 15 feet wide by the continuous-mining machine, which moves along the center of the place. The average advance of the continuous-mining machine is 50 feet per shift. Crosscuts are staggered to minimize roof caving caused by wide openings. Five- by 7-inch wood crossbars, 14 feet long, set on 4-foot centers on steel timber jacks, are used to support the roof. The crossbars are kept at least 3 feet in advance of the operator. The steel jacks are replaced with wood posts by the timbermen as the continuous-mining machine advances.

A continuous-mining unit comprises 7 men, 1 continuous-mining machine, 1 mobile-loading machine, and 1 cable-reel shuttle car. The continuous-mining machine deposits the mined coal on the floor, which provides adequate surge capacity and allows the continuous-mining machine to be operated with a minimum of shuttle-car haulage delays. The mobile-loading machine reloads the coal into a 6-ton-capacity shuttle car, which transports the coal to the unloading station. The shuttle car is equipped with an elevating conveyor, which discharges the coal into 5.2-ton-capacity, steel mine cars.

A continuous-mining crew consists of 7 men as follows:

Section foreman..................................	1
Continuous-mining-machine operator.............	1
Loading-machine operator........................	1
Shuttle-car operator............................	1
Timbermen.......................................	2
Electrician-mechanic............................	1
Total...	7

Travel time at this mine is 1 hour; lunch time, 30 minutes; leaving 6 hours 30 minutes face time per shift. The average delay caused by mechanical failure is 1 hour, 15.4 percent of face time. Other delays, such as retracting or maneuvering the continuous-mining machine, power failure, and waiting on empty cars amount to 1 hour 20 minutes, 20.5 percent of face time. Actual productive time is 4 hours 10 minutes, 64.1 percent of face time. All maintenance, moving, and other work necessary to keep the continuous-mining machine operating is done by a mechanic at the beginning of the shift or on shift, when necessary.

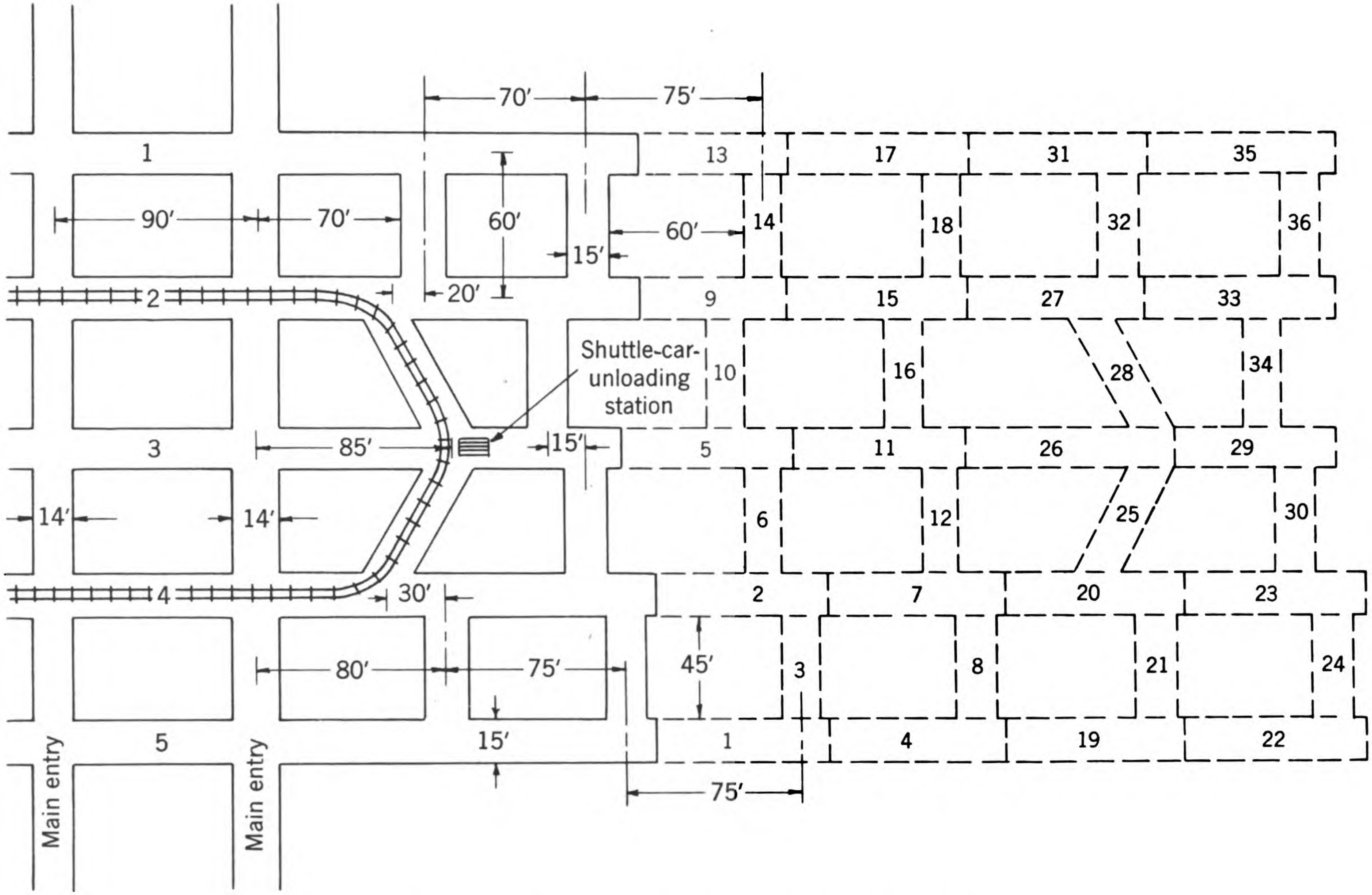

Figure 63. - Butt-entry-development at mine 19.

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Classification of Employees

Classification	Shift[1] 1st	2d	3d	Total
Type A continuous-mining unit:				
Section foremen	1	1	1	3
Continuous-mining-machine operators	1	1	1	3
Loading-machine operators	1	1	1	3
Shuttle-car operators	1	1	1	3
Timbermen	2	2	2	6
Electrician-mechanics	1	1	1	3
Total employees, continuous-mining unit	7	7	7	21
Total employees, mobile-loading units	71	71	71	213
Supervisory and inspection	4	2	2	8
Other underground employees	58	20	20	98
Total underground employees	140	100	100	340
Total surface employees	46	17	17	80
Total surface and underground employees	186	117	117	420

---

[1] 1st shift - 6:30 a.m. to 2:30 p.m.
2d shift - 2:30 p.m. to 10:30 p.m.
3d shift - 10:30 p.m. to 6:30 a.m.

Summary

	Continuous mining	Conventional mining
Percent of mine production	12	88
Hours per shift	8	8
Unit shifts per day	3	15
Average yield of clean coal percent	92	92
Average advance of continuous-mining machine per shift feet	50	-
Employees:		
In unit crews	21	213
Supervisory and other underground	13	93
Surface	10	70
Total charged to	44	376
Average daily production, raw coal tons	626	4,591
Average production, raw coal per unit per shift tons	209	306
Average production, raw coal per man per shift on unit tons	29.8	21.6
Average production, raw coal per underground man shift tons	18.4	15.0
Average production, raw coal per payroll man shift tons	14.2	12.2

Mine 20

Location	West Virginia
Coal bed and thickness (fig. 64) ... inches	Pittsburgh No. 8 - 62 (58 inches mined)
Thickness of overburden ... feet	600
Production per day, raw coal ... tons	1,700
Total employees	228
Type A continuous-mining machines:	
Room mining	3
Mobile-loading units	3
Shifts per day	2
System of mining (fig. 65)	Room-and-pillar, pillars not extracted
Estimated recovery of coal in place ... percent	60
Mainline haulage	Locomotive

Mining Method

Three type A continuous-mining machines, operated 6 unit shifts per day, are used to develop rooms from butt entries in 3 separate panels. Rooms are turned on 25-foot centers on 60° from the butt entries and driven 16 feet wide and 275 feet deep. (See fig. 66.) Crosscuts between rooms are 16 feet wide and are turned on 80-foot centers on an angle of 45°. Mining is begun in the inby room off the return-air course and after eight rooms are completed, rooms are mined similarly off the intake-air-course entry. Rooms are completed in groups of eight alternately off the return- and intake-air-course entries. A 50-foot pillar of coal is left between each 2 adjacent groups of rooms. In mining, 4 inches of top coal are left to support the roof. Four-inch, steel H-beams, 13 feet long and spaced on 3-foot centers, are set on wood posts to support the roof. These H-beams and posts are recovered when a room is finished.

A continuous-mining unit comprises 7-1/6 men, 1 continuous-mining machine, and 2 cable-reel shuttle cars. One of the shuttle cars is used behind the continuous-mining machine as a surge car, which permits continuous-mining of coal while the shuttle car transports coal to the unloading station.

The continuous-mining machine is crawler-mounted and moves along the center line of the room while cutting a 16-foot room. The average advance of the continuous-mining machine is 50 feet per shift. Two timbermen, one on each side of the mining machine, keep the crossbars and posts at least 3 feet in advance of the operator. The shuttle car transports the coal from the surge car and discharges it into mine cars of 1.9-ton capacity at unloading stations. (See B, fig. 66.) The unloading station consists of a wood ramp in a crosscut that has been top brushed and roof bolted.

A continuous-mining crew consists of 7-1/6 men as follows:

Section foreman	2/3
Continuous-mining-machine operator	1
Shuttle-car operators	2
Timbermen	2
Electrician-mechanics	[1]1-1/2
Total	7-1/6

[1] One-half man included from third-shift maintenance crew.

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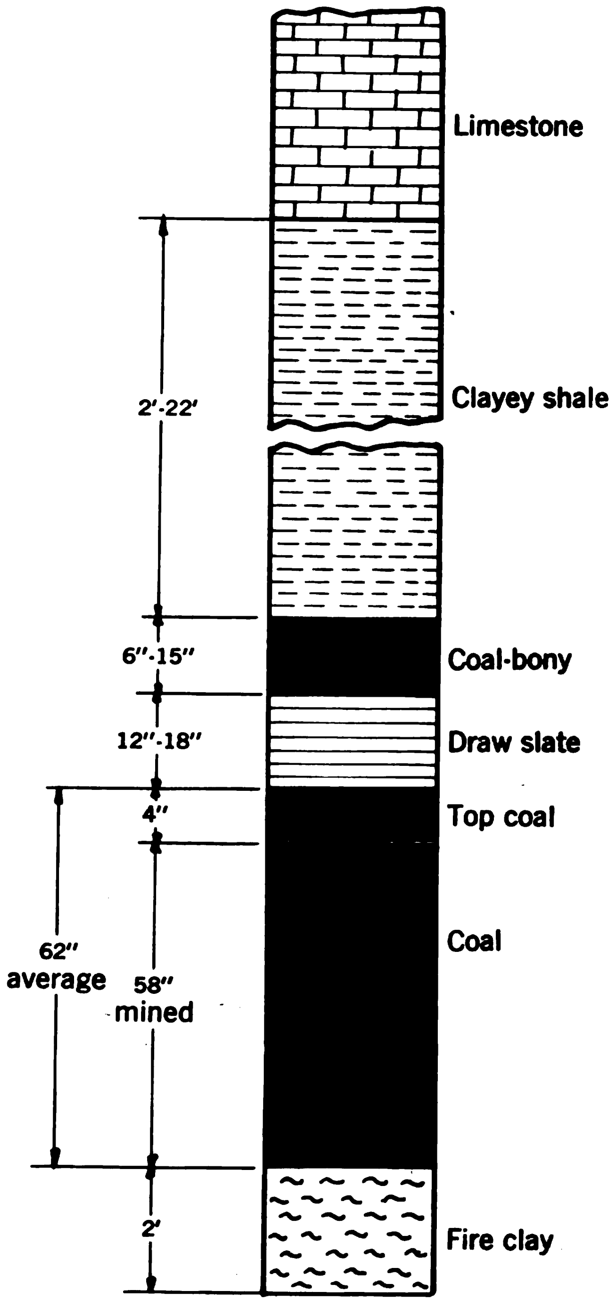

Figure 64. - Section of roof, coal bed, and bottom at mine 20.

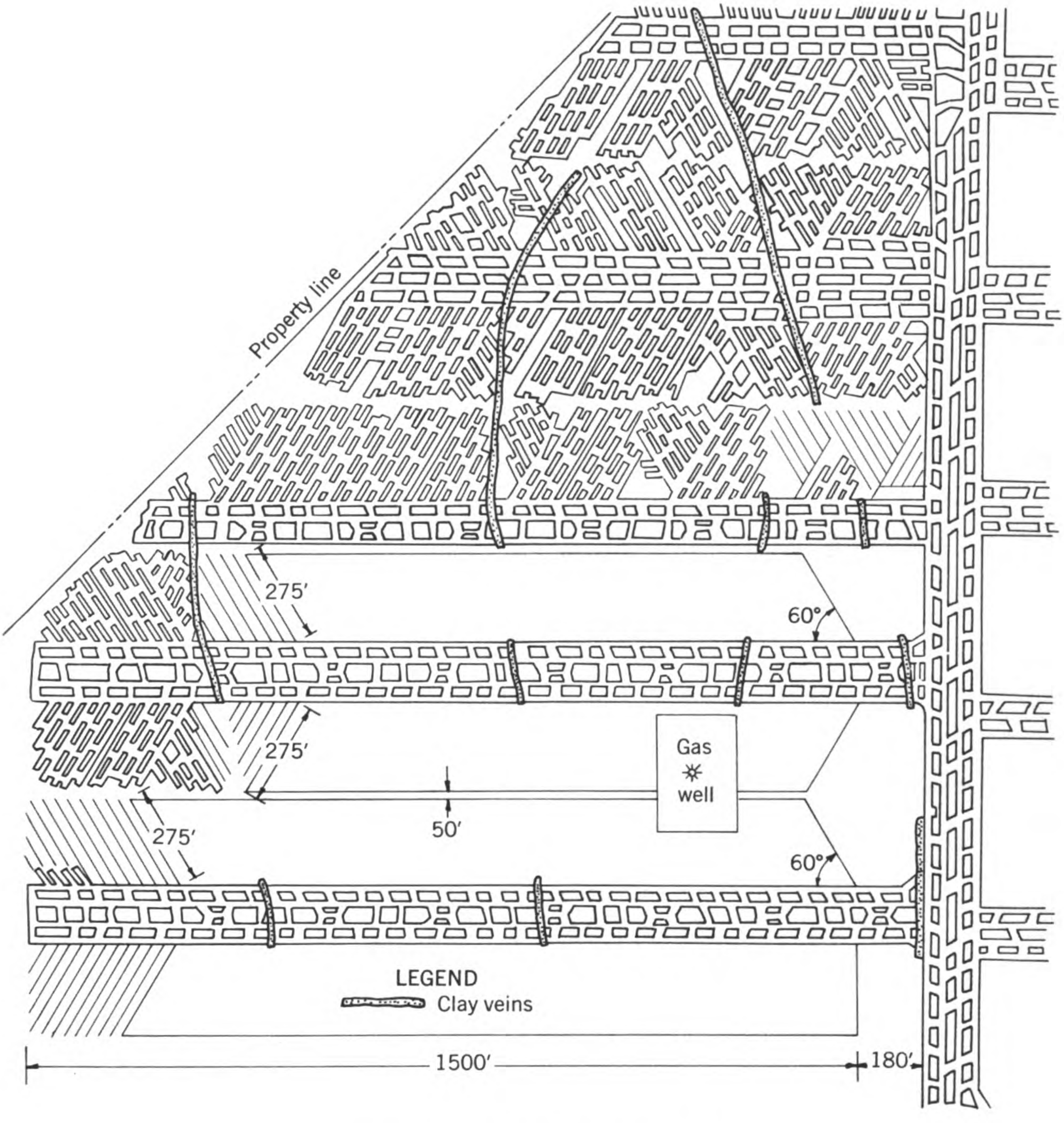

Figure 65. - Mining method at mine 20.

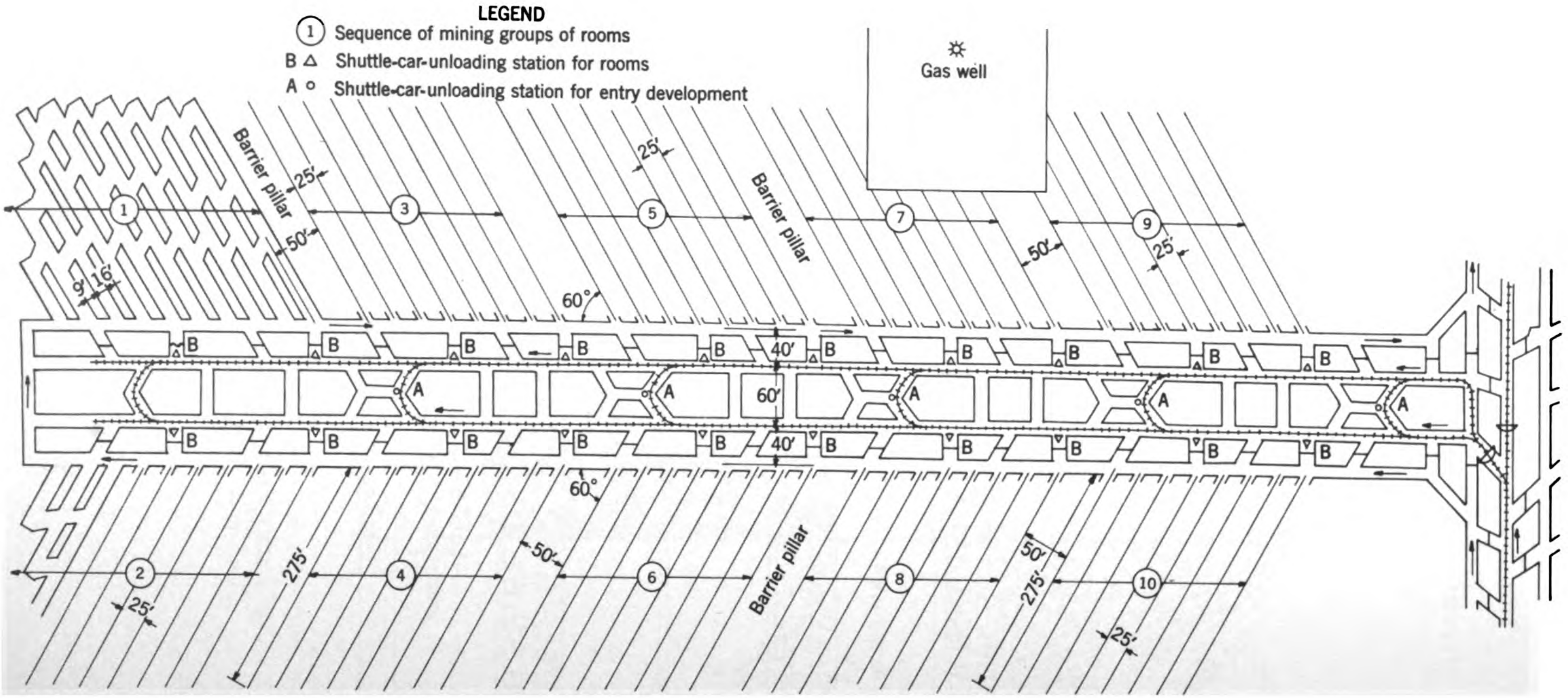
LEGEND
① Sequence of mining groups of rooms
B △ Shuttle-car-unloading station for rooms
A ○ Shuttle-car-unloading station for entry development
Gas well
Barrier pillar
Barrier pillar
Barrier pillar
1
2
3
4
5
6
7
8
9
10
25'
50'
9'
16'
60°
40'
60'
275'
A
B

Figure 66. - Room mining at mine 20.

Travel time at this mine is 1 hour 30 minutes; lunch time, 30 minutes; leaving 6 hours face time per shift. The average delay caused by mechanical failure is 36 minutes, 10 percent of face time. Other delays, such as retracting or maneuvering the continuous-mining machine, power failure, and shuttle-car delays, amount to 18 minutes, 5 percent of face time. Actual productive time is 5 hours 6 minutes, 85 percent of face time. All repairs, greasing, moving, and other work necessary to maintain and keep the continuous-mining machines operating are done on the third shift. The bits in the cutting chains are used two shifts and replaced during the third shift.

Classification of Employees

	Shift[1/]			
Classification	1st	2d	3d	Total
Type A continuous-mining units:				
Section foremen	2	2	-	4
Continuous-mining-machine operators	3	3	-	6
Shuttle-car operators	6	6	-	12
Timbermen	6	6	-	12
Electrician-mechanics	3	3	3	9
Total employees, continuous-mining units	20	20	3	43
Total employees, mobile-loading units	33	33	6	72
Supervisory and inspection	2	-	1	3
Other underground employees	47	21	18	86
Total underground employees	102	74	28	204
Total surface employees	16	7	1	24
Total surface and underground employees	118	81	29	228

[1/] 1st shift - 7:00 a.m. to 3:00 p.m.
2d shift - 3:30 p.m. to 11:30 p.m.
3d shift - 11:00 p.m. to 7:00 a.m.

Summary

	Continuous mining		Conventional mining	
Percent of mine production	50		50	
Hours per shift	8		8	
Unit shifts per day	6		6	
Average yield of clean coal.....percent	98		98	
Average advance of continuous-mining machine per shift.....feet	50		-	
Employees:				
In unit crews		43		72
Supervisory and other underground		44-1/2		44-1/2
Surface		12		12
Total charged to	99-1/2		128-1/2	
Average daily production, raw coal.....tons	850		850	
Average production, raw coal per unit per shift.....tons	141.7		141.7	
Average production, raw coal per man per shift on unit.....tons	19.8		11.8	
Average production, raw coal per underground man shift.....tons	9.7		7.3	
Average production, raw coal per payroll man shift.....tons	8.5		6.6	

Table 4 is a summary of performance of continuous-mining units at each mine compared with that of other units at the same mine. The data are taken from descriptions of the mining operations and tabulated for ready reference.

TABLE 4. - Summary of performance of continuous-mining, mobile-loading, and hand-loading units

		Mine																						
		1	2		3	4	5	6	7	8	9	10	11	12	13	14	15	16		17	18	19	20	
1.	Location of mine	Ala.	Ill.		Ill.	Ill.	Ky.	Ohio	Pa.	Pa.	Pa.	Pa.	Pa.	Pa.	Pa.	Pa.	Pa.	W. Va.		W. Va.	W. Va.	W. Va.	W. Va.	1.
2.	Mechanization of mine .... percent	100	100		100	100	100	100	100	100	80.2	100	100	100	100	100	100	100		100	100	100	100	2.
3.	Total thickness of bed .... inches	54	108		102	102	60	60	50	42	41	48	50	69	74	78	86	48 to 59		54	72	85	62	3.
4.	Thickness of bed mined .... do.	54	84		102	84	48	57	42	42	41	43	42	55	74	90	76	42 to 53		54	72	73	58	4.
5.	Number of 8-hour shifts per day	2	2		2	2	2	2	3	3	3	3	3	3	3	3	3	3		2	3	3	2	5.
6.	Average daily production, raw coal .... tons	6,712	7,527		5,060	9,800	1,200	2,350	2,857	1,800	4,058	1,500	5,235	1,600	2,828	5,883	8,750	1,111		700	2,609	5,217	1,700	6.
7.	Total number of employees, underground	431	270		266	515	66	188	261	106	683	166	650	147	240	525	794	113		37	115	340	204	7.
8.	Total number of employees, surface and underground	521	388		382	700	88	223	314	157	843	193	721	175	287	644	1,004	133		55	140	420	228	8.
9.	Average production per shift per man employed .... tons	12.9	19.4		13.2	14.0	13.6	10.5	9.1	11.5	4.8	7.8	7.3	9.1	9.9	9.1	8.7	8.4		12.7	18.6	12.4	7.5	9.
10.	Pillars extracted	No	Yes		No	No	Yes	No	No	No	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes		Yes	Yes	No	No	10.
11.	Main line haulage	Track	Belt		Track	Track	Belt	Track	Track	Belt	Track	Track	Track and belt	Track	Track	Track	Track	Track and belt		Belt	Track	Track	Track	11.
12.	Percent recovery[1]	65	90		45	50	90	65	55	63	93	90	91	90	85	85	96	80		-	68 to 92	52	60	12.
13.	Continuous-mining machine units:																							13.
	a. Type and number	A-6	A-3	C-9	A-1	A-2	A-4	A-1	A-2	A-3	B-2	A-3	A-6	A-1	A-5	A-2	A-1	A-2	B-1	A-1	B-1	A-1	A-3	
	b. Unit shifts per day	12	6	18	2	2	8	2	6	9	6	9	16	2	15	6	2	6	2	2	3	3	6	
	c. Average daily production, raw coal .... tons	4,430	1,882	5,645	587	556	1,200	399.5	628.5	1,251	1,079.4	1,200	1,937	360	2,828	1,236	420	631	202	500	1,696	626	850	
	d. Percent of total production	66	25	75	11.6	5.7	100	17	22	69.5	26.6	80	37	22.5	100	21	4.8	56.8	18.2	71.5	65	12	50	
	e. Average production per unit per shift .... tons	369.2	313.6	313.6	293.5	278	150	199.7	104.8	139	179.9	133.3	121	180	188.5	206	210	105.2	101	250	565	209	141.7	
	f. Average number of men per unit per shift	8	6-1/2	6-1/2	6	4-1/2	6-1/2	6-1/2	6	6	6-1/2	6	5-1/3	6-1/2	7	7	7	5-1/2	8	6-1/2	8	7	7-1/6	
	g. Man shifts per day	96	39	117	12	9	52	13	36	53	39	54	85	13	105	42	13	33	15	13	24	21	43	
	h. Average production per man per shift .... tons	46.1	48.3	48.3	48.9	61.8	23.1	30.7	17.5	23.6	27.7	22.2	22.8	27.7	26.9	29.4	32.3	19.1	13.5	38.5	70.6	29.8	19.8	
	i. Average production per man per shift, underground . do.	18.6	27.9	27.9	28.0	23.2	18.2	16.6	12.1	19.3	-	10.3	10.5	14.4	11.8	16.2	16.2	14.0	10.6	22.7	28.3	18.4	9.7	
	j. Average production per payroll man shift .... do.	14.9	19.4	19.4	17.3	16.1	13.6	13.3	9.8	12.5	-	8.6	9.2	11.6	9.8	12.2	12.0	11.3	8.8	14.3	22.3	14.2	8.5	
14.	Mobile-loading units:																							14.
	a. Number of units	6	-		6	12	-	8	6	1	8	1	17	3	-	10	15	-		1	1	5	3	
	b. Unit shifts per day	12	-		12	24	-	15	18	3	24	3	37	8	-	30	30	-		1	3	15	6	
	c. Average daily production, raw coal .... tons	2,282	-		4,473	9,244	-	1,950.5	2,228.5	549	2,175.1	300	3,298	1,240	-	4,647	8,330	-		200	913	4,591	850	
	d. Percent of total production	34	-		88.4	94.3	-	[illegible]	78	30.5	53.6	20	63	77.5	-	79	95.2	-		28.5	35	88	50	
	e. Average production per unit per shift .... tons	190.2	-		373	385	-	130	123.8	183	90.6	100	89.1	155	-	154.9	277.7	-		200	304	306	141.7	
	f. Average number of men per unit per shift	10	-		14-1/2	10	-	7-1/2	8-1/2	12	9-1/2	11	8	10	-	10-1/2	16	-		12	12	14	12	
	g. Man shifts per day	120	-		173	232	-	115	151	36	225	33	298	80	-	321	480	-		12	36	213	72	
	h. Average production per man per shift .... tons	19.0	-		25.9	39.8	-	17.[illegible]	14.8	15.3	9.7	9.1	11.1	15.5	-	14.5	17.4	-		16.7	25.3	21.6	11.8	
	i. Average production per man per shift, underground . do.	11.8	-		18.3	18.8	-	11.9	10.7	13.4	-	6.1	7.1	10.2	-	10.3	10.8	-		13.3	16.6	15.0	7.3	
	j. Average production per payroll man shift .... do.	10.2	-		12.9	13.9	-	10.1	8.9	9.6	-	5.6	6.5	8.6	-	8.5	8.6	-		10.0	14.3	12.2	6.6	
15.	Hand-loading units:																							15.
	a. Number of units	-	-		-	-	-	-	-	-	[2]4	-	-	-	-	-	-	[3]3		-	-	-	-	
	b. Unit shifts per day	-	-		-	-	-	-	-	-	4	-	-	-	-	-	-	6		-	-	-	-	
	c. Average daily production, raw coal .... tons	-	-		-	-	-	-	-	-	803.5	-	-	-	-	-	-	278		-	-	-	-	
	d. Percent of total production	-	-		-	-	-	-	-	-	19.8	-	-	-	-	-	-	25		-	-	-	-	
	e. Average production per unit per shift .... tons	-	-		-	-	-	-	-	-	200.9	-	-	-	-	-	-	46.3		-	-	-	-	
	f. Average number of men per unit per shift	-	-		-	-	-	-	-	-	33	-	-	-	-	-	-	7		-	-	-	-	
	g. Man shifts per day	-	-		-	-	-	-	-	-	132	-	-	-	-	-	-	44		-	-	-	-	
	h. Average production per man per shift .... tons	-	-		-	-	-	-	-	-	6.1	-	-	-	-	-	-	6.3		-	-	-	-	
	i. Average production per man per shift, underground . do.	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	5.7		-	-	-	-	
	j. Average production per payroll man shift .... do.	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	5.1		-	-	-	-	

[1] Recovery figure furnished by company.

[2] Four sections in mine loading into mine cars.

[3] Loading onto chain conveyors.

Interior-Bureau of Mines, Pittsburgh, Pa. 6219